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1 Introduction

The *Technical Manual* is intended to provide a basic, but limited, understanding of the mechanical and electrical operation of Deltec CADD-1®, CADD-PCA®, CADD-PLUS®, and CADD-TPN® Computerized Ambulatory Drug Delivery (CADD®) pumps to persons familiar with these computerized devices. The CADD-1, CADD-PCA, CADD-PLUS, and CADD-TPN Operator Manuals should be used in conjunction with this publication for complete information.

This manual also outlines cleaning and functional testing procedures that can be performed on the CADD pumps. Deltec recommends annual inspection and testing of CADD pumps to verify function and accuracy.

IMPORTANT NOTICE:

The CADD-1, CADD-PCA, CADD-PLUS, and CADD-TPN pump operations and safety features are based on a microcomputer design. Inadequate servicing or tampering with the safety features of the pumps may seriously affect performance and safety.

For that reason, **ALL SERVICING AND REPAIR OF THE CADD-1, CADD-PCA, CADD-PLUS, AND CADD-TPN PUMPS MUST BE PERFORMED BY DELTEC OR ITS AUTHORIZED AGENTS.**

The manufacturer's warranty agreement shall become null and void if

- the pumps are not used in accordance with the Operator Manuals and Instructions for Use for the pump accessories; or,
- the pumps are serviced by persons other than Deltec or those authorized by Deltec.

Limited Warranty

The limited warranty associated with CADD-1, CADD-PCA, CADD-PLUS, and CADD-TPN pumps can be found in the product literature supplied with the product when originally purchased, which is incorporated herein by reference. DELTEC SPECIFICALLY DISCLAIMS ANY OTHER WARRANTY, WHETHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR USE. Deltec further disclaims responsibility for the suitability of the system for a particular medical treatment or for any medical complications resulting from the use of the system. The manufacturer shall not be responsible for any incidental damages or consequential damages to property, loss of profits, or loss of use caused by any defect or malfunction of the system.

If you wish to receive additional information about the extent of the warranty on these products, please contact your Deltec representative or call Clinical Services at 1-800-426-2448.

All recommendations, information, and literature supplied by Deltec with respect to the CADD product line are believed to be accurate and reliable, but do not constitute warranties. No agent, representative, or employee of Deltec has authority to bind Deltec to any representation or warranty, expressed or implied.

Exposure to Radiation or Magnetic Resonance Imaging (MRI)

CAUTIONS:

(1) The pumps SHOULD NOT BE DIRECTLY IRRADIATED by therapeutic levels of ionizing radiation because of the risk of permanent damage to the pump's electronic circuitry. The best procedure to follow is to remove the pump from the patient during therapeutic radiation sessions or diagnostic levels of radiographic and fluoroscopic radiation. If the pump must remain in the vicinity during a dianostic or therapy session, it should be shielded, and its ability to function properly should be confirmed following treatment.

(2) Magnetic fields produced by magnetic resonance imaging (MRI) equipment may adversely affect the operation of the pump. Remove the pump from the patient during MRI procedures and keep it at a safe distance from magnetic energy.

2 CADD-1® Pump Model 5100 Series

Delivery Modes

The CADD-1 Model 5100 series pumps may be used for intravenous, subcutaneous, or intra-arterial drug delivery (excluding insulin). The CADD-1 pump may be programmed for continuous delivery of medication at a constant rate. (See Figure 1.) The pump's flexibility allows it to be used in a variety of settings. Figure 2 shows a diagram of the CADD-1 Model 5100 series pump.

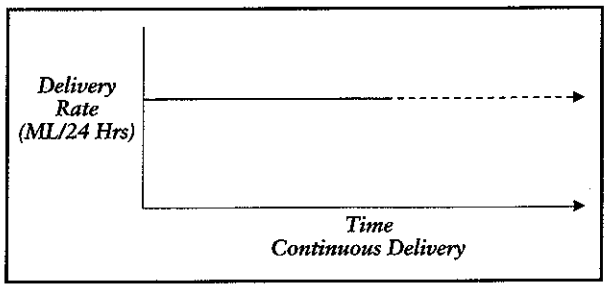


Figure 1. CADD-1 Model 5100 series pump delivery profile.

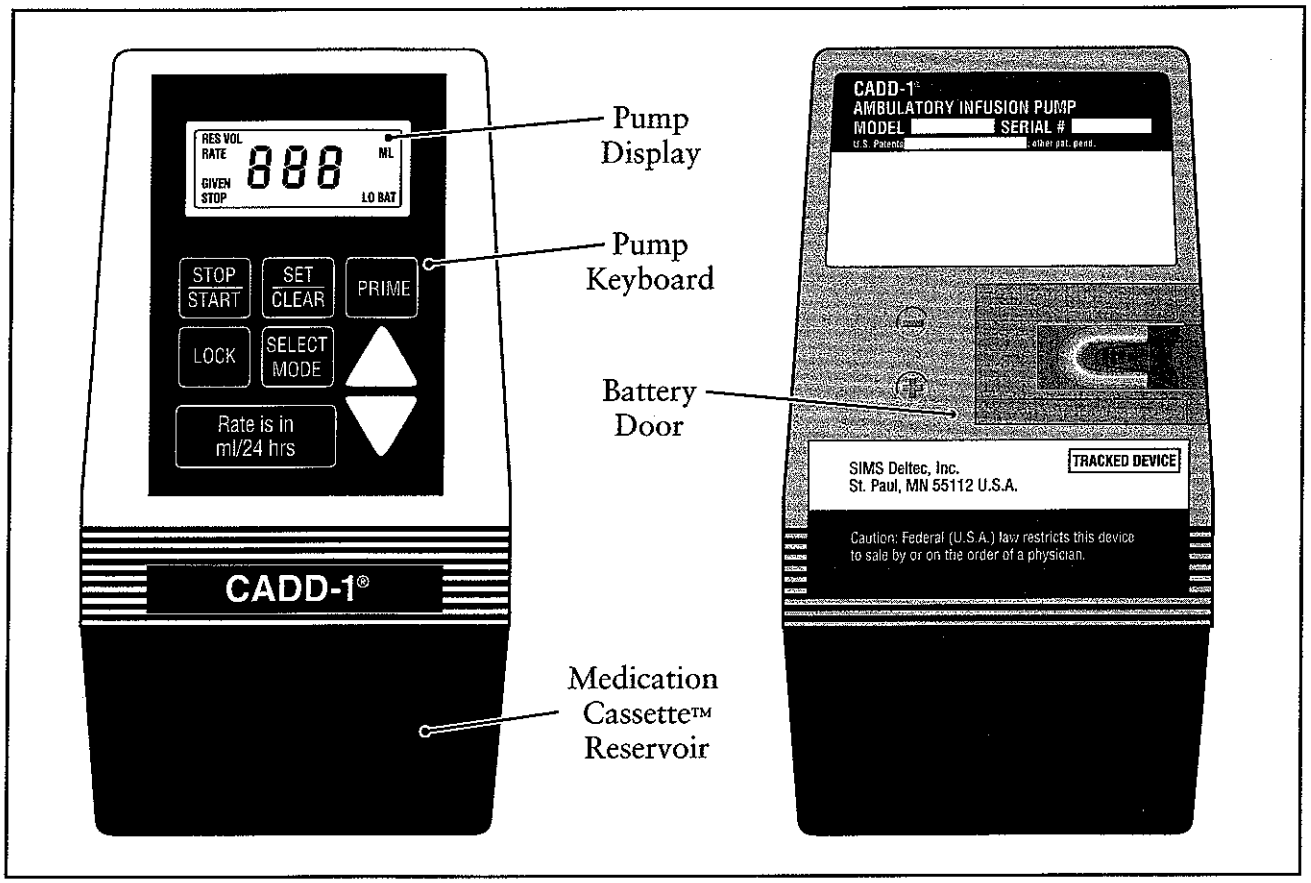


Figure 2. Front and back views of the CADD-1 Model 5100 series pump.

Technical Specifications (Nominal)

Programming Modes

RATE:

Model 5100: 000–299 ml/24 hrs in 1-ml increments.

Models 5100 HF, 5101 HF, and 5100 HFX: 000–299 ml/24 hrs in 1-ml increments; Continuous High Flow fixed at 90 ml/hr.

Record-keeping Modes

Reservoir-residual Volume (RES VOL): 000–999 ml in 1-ml increments, rounded up to nearest ml; or RES VOL OFF (RES VOL set to 000).

ML GIVEN: 000–999 ml rounded down to nearest ml; pump continues recording after 999 ml but resets counter to 000.

Pump Characteristics

Volumetric Resolution: 50 microliters per interval.

Delivery Interval: Dependent on rate setting; from 14.5 sec (299 ml/24 hrs) to 72 min (1 ml/24 hrs).

Delivery Accuracy: ± 6%, nominal.

Dimensions

Size: 2.8 cm x 8.9 cm x 16.0 cm (1.1 in x 3.5 in x 6.3 in) including a 50-ml Medication Cassette™ reservoir.

Weight: 320 grams (11 ounces)

Alarms

Alarm Functions:

- Pump in Stop mode.
- Low reservoir-residual volume.
- Reservoir-residual volume at 000.
- Low battery warning.
- Battery depleted.
- Hardware and software fault detection.
- High delivery pressure: 28 ± 12 psi (Models HF and HFX).

Power

Power Sources:

Models 5100, 5100 HF, and 5101 HF: 9-volt alkaline battery. (Use DURACELL® MN 1604 or EVEREADY® #522, for example.)

Model 5100 HFX only: 9-volt alkaline or lithium battery. (Use ULTRALIFE® Lithium U9VL.)

The External Power Source (EPS) system may also be used to power the pump.

Reservoir Capacities

Sizes:

- 50-ml Medication Cassette reservoir.
- 100-ml Medication Cassette reservoir.
- CADD administration set with 60-inch tubing and integral anti-siphon valve.
- CADD administration set with 60-inch tubing, integral anti-siphon valve and bag spike.
- CADD administration set with 80-inch yellow-striped tubing, integral anti-siphon valve and bag spike.
- CADD administration set with 60-inch tubing, add-on anti-siphon valve and bag spike.
- CADD administration set with 60-inch blue-striped TOTM-plasticized tubing, add-on anti-siphon valve and bag spike.
- CADD administration set with 75-inch TOTM-plasticized spiral tubing, 0.2-micron air-eliminating filter, add-on anti-siphon valve and bag spike.
- CADD administration set with 75-inch TOTM-plasticized spiral tubing, 1.2-micron air-eliminating filter, add-on anti-siphon valve and bag spike.

Environmental Requirements

Operating Temperature Range: +2°C to 40°C (35°F to 104°F).

Storage Temperature Range: -40°C to 55°C (-40°F to 131°F).

Humidity Range: 10% to 90% relative humidity noncondensing.

3 CADD-PCA® Pump Model 5200 Series

Delivery Modes

The CADD-PCA Model 5200 series pumps may be used to provide patient-controlled analgesia therapy. CADD-PCA Model 5200 series pumps are intended to be used for intravenous, subcutaneous, or epidural drug delivery. Epidural administration is limited to short-term infusion of anesthetics and either long- or short-term infusion of analgesics. The pump's flexibility allows it to be used in a variety of settings. CADD-PCA Model 5200 series pumps may be programmed to deliver medication one of three ways: (1) Continuous rate only, (2) Patient-activated dose only, and (3) Continuous rate and patient-activated dose. (See Figure 3.) Figure 4 shows a diagram of the CADD-PCA Model 5200 series pump.

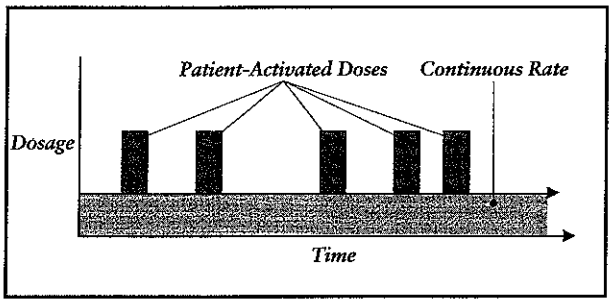


Figure 3. CADD-PCA Model 5200 series pump delivery profile.

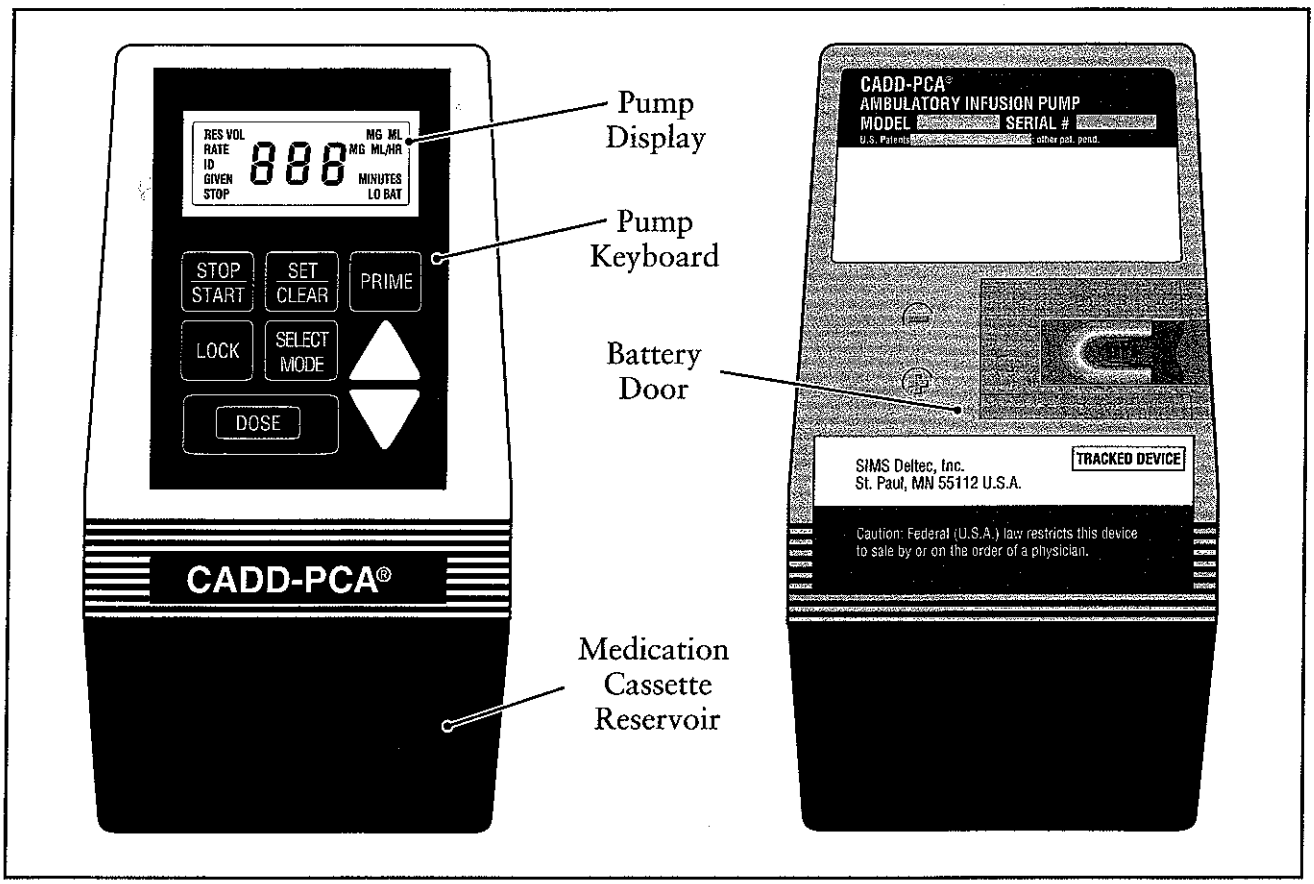


Figure 4. Front and back views of the CADD-PCA Model 5200 series pump.

Technical Specifications (Nominal)

Programming Modes

Concentration (MG/ML):

Models 5200 and 5200P: 00.5, 01.0, 02.0, 05.0, 10.0, 15.0 mg/ml.

Model 5200 PXC: 00.5, 01.0, 02.0; and 05.0 to 95.0 mg/ml in 5.0-mg/ml increments.

RATE: 0–99.5 mg/hr (See Table 1.)

Incremental DOSE (ID):

Models 5200 and 5200P: 0–49.5 mg

Model 5200 PXC: 0–99.5 mg (See Table 1.)

Incremental Dose (ID MINUTES) (minimum period of time between incremental dose): 5–199 min in 1-min increments. Removing and replacing the battery in LL0 allows an immediate incremental dose; after removing and replacing the battery on LL1 and LL2 the entire incremental dose minutes must elapse before a dose can be given.

Incremental Doses/Hour (ID/HR): 0–12/hr over the previous 60 min; removing battery clears counter.

NOTE:

Model 5200 PXC programming increments for rate and dose are different than Models 5200 and 5200P for concentration of 10mg/ml. (See Table 1.)

Table 1. Parameter settings for the CADD-PCA Model 5200 series pumps.

Concentration (mg/ml)	Rate Increment (mg/ml)	Maximum Rate (mg/hr)	Incremental Dose Increments (mg)	Maximum Incremental Dose (mg)	MG GIVEN Increment Rounded Down
0.5	0.1	9.9	0.1	1.9	1
1	0.1	19.9	0.1	3.9	1
2	0.1	39.9	0.1	7.9	1
5	0.5	99.5	0.5	19.5	1
10*	1.0*	99.0*	1.0*	40.0*	2*
10**	0.5**	99.5**	0.5**	39.5**	2**
15	1.5	99.0	1.5	49.5	3
20	2.0	98.0	2.0	98.0	4
25	2.5	97.5	2.5	97.5	5
30	3.0	99.0	3.0	99.0	6
35	3.5	98.0	3.5	98.0	7
40	4.0	96.0	4.0	96.0	8
45	4.5	99.0	4.5	99.0	9
50	5.0	95.0	5.0	95.0	10
55	5.5	99.0	5.5	99.0	11
60	6.0	96.0	6.0	96.0	12
65	6.5	97.5	6.5	97.5	13
70	7.0	98.0	7.0	98.0	14
75	7.5	97.5	7.5	97.5	15
80	8.0	96.0	8.0	96.0	16
85	8.5	93.5	8.5	93.5	17
90	9.0	99.0	9.0	99.0	18
95	9.5	95.0	9.5	95.0	19

* 5200 PXC only;
** 5200 and 5200P only

Record-keeping Modes

Reservoir-residual Volume (RES VOL): 000–999 in 1-ml increments, rounded up to nearest ml; or RES VOL OFF (RES VOL set to 000).

Incremental Doses (ID) GIVEN: 000–999; pump continues recording after 999 but resets counter to 000.

MG GIVEN: 000–999 mg, rounded down to nearest increment (See Table 1); pump continues recording after 999 mg but resets counter to 000.

Pump Characteristics

Volumetric Resolution: 50 microliters per interval.

Continuous Delivery Interval: Dependent upon concentration and continuous delivery settings.

Delivery Accuracy: ± 6%, nominal.

Dimensions

Size: 2.8 cm x 8.9 cm x 16.0 cm (1.1 in x 3.5 in x 6.3 in) including a 50-ml Medication Cassette reservoir.

Weight: 320 grams (11 ounces).

Alarms

Alarm Functions:

- Pump in Stop mode.
- Low reservoir-residual volume.
- Reservoir-residual volume at 000.
- Low battery warning.
- Battery depleted.
- Hardware and software fault detection.
- High delivery pressure: 28 ± 12 psi (Models 5200P and 5200 PXC only).
- Conflicting program values.

Power

Power Sources: 9-volt alkaline battery. (Use DURACELL MN 1604 or EVEREADY #522, for example.)

The External Power Source (EPS) system may also be used to power the pump.

Reservoir Capacities

Sizes:

- 50-ml Medication Cassette reservoir.
- 100-ml Medication Cassette reservoir.
- CADD administration set with 60-inch tubing and integral anti-siphon valve.
- CADD administration set with 60-inch tubing, integral anti-siphon valve and bag spike.
- CADD administration set with 80-inch yellow-striped tubing, integral anti-siphon valve and bag spike.
- CADD administration set with 60-inch tubing, add-on anti-siphon valve and bag spike.
- CADD administration set with 60-inch blue-striped TOTM-plasticized tubing, add-on anti-siphon valve and bag spike.
- CADD administration set with 75-inch TOTM-plasticized spiral tubing, 0.2-micron air-eliminating filter, add-on anti-siphon valve and bag spike.
- CADD administration set with 75-inch TOTM-plasticized spiral tubing, 1.2-micron air-eliminating filter, add-on anti-siphon valve and bag spike.

Environmental Requirements

Operating Temperature Range: +2°C to 40°C (35°F to 104°F).

Storage Temperature Range: -40°C to 55°C (-40°F to 131°F).

Humidity Range: 10% to 90% relative humidity noncondensing.

4 CADD-PCA® Pump Model 5800 Series

Delivery Modes

The CADD-PCA Model 5800 series pumps may be used to provide patient-controlled analgesia therapy. CADD-PCA Model 5800 series pumps are intended to be used for intravenous, subcutaneous, subarachnoid or epidural drug delivery. Epidural and subarachnoid administration is limited to short-term infusion of anesthetics and either long- or short-term infusion of analgesics. The pump's flexibility allows it to be used in a variety of settings. CADD-PCA Model 5800 series pumps may be programmed to deliver medication in one of four ways: (1) Continuous rate only, (2) Patient-activated dose only, (3) Continuous rate and patient-activated dose, and (4) Clinician-activated bolus (alone or in combination with 1, 2, or 3). (See Figure 5.) Figure 6 shows a diagram of the CADD-PCA Model 5800 series pump.

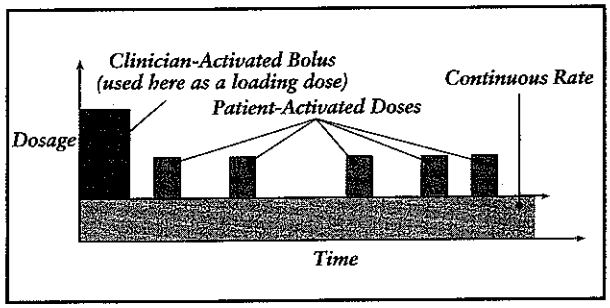


Figure 5. CADD-PCA Model 5800 series pump delivery profile.

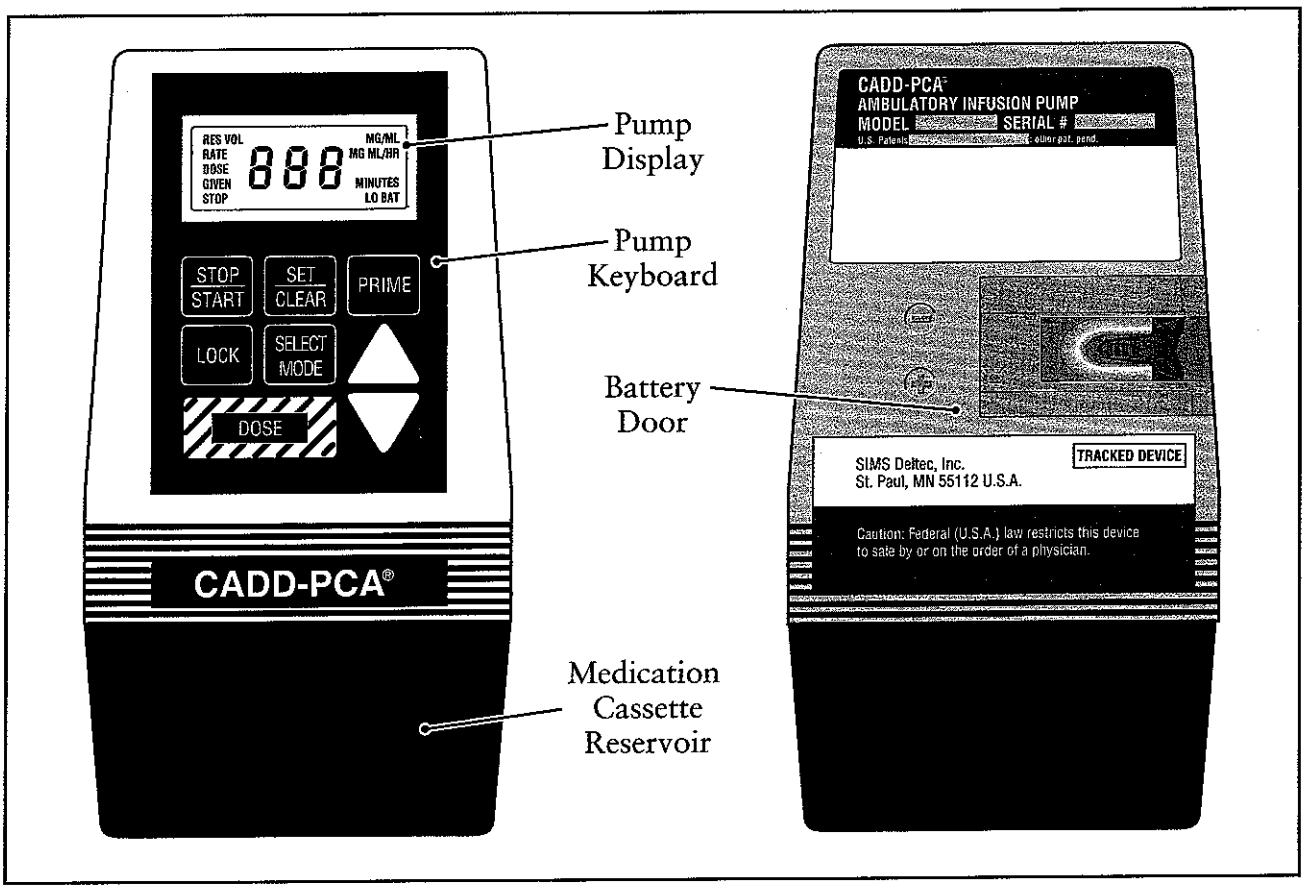


Figure 6. Front and back views of the CADD-PCA Model 5800 series pump.

CADD-PCA Pump Model 5800R

The CADD-PCA Model 5800R pump, like the CADD-PCA Model 5800 and 5200 series, may be used to provide patient-controlled analgesic therapy. The feature of the CADD-PCA Model 5800R pump that makes it unique is the REMOTE DOSE cord. The patient can press the REMOTE DOSE button or the DOSE key to deliver a preprogrammed amount of medication. In the Start mode, the REMOTE DOSE button can be used in place of the DOSE key to initiate the clinician-activated bolus or patient-activated dose. (See Figures 5 and 7.)

NOTE:

To detach the REMOTE DOSE cord/button from the REMOTE DOSE adapter, grasp the ridged grip of the REMOTE DOSE adapter and the sliding collar of the REMOTE DOSE cord/button. Pull the ridged grip on the sliding collar of the connector back until you feel it stop. Continue to pull the REMOTE DOSE cord/button connector out of the REMOTE DOSE adapter connector. Use a steady, even pull to separate the connectors. **Do not** use a screwing or twisting motion.

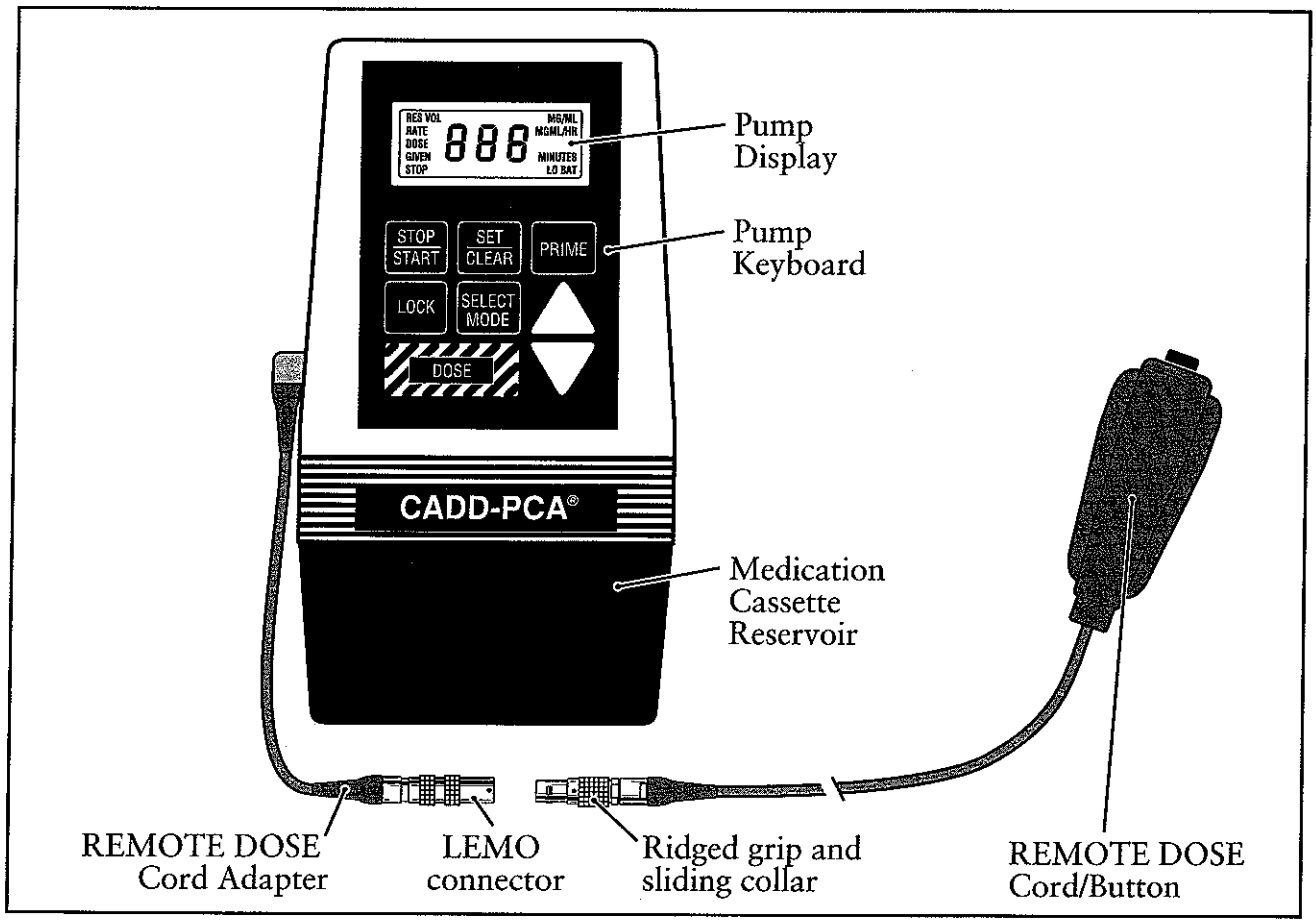


Figure 7. The CADD-PCA Model 5800R pump with the REMOTE DOSE cord.

Technical Specifications (Nominal)

Programming Modes

Concentration (MG/ML): 0, 0.5, 1.0, 2.0, 4.0; and 5.0 to 95.0 mg/ml in 5.0-mg/ml increments.

Continuous RATE: 0–99.5 mg/hr or 0–20 ml/hr (See Table 2.)

Patient-activated DOSE: 0–99.0 mg or 0–6 ml (See Table 2.)

Patient-activated DOSE Minutes (minimum period of time between incremental doses): 5–999 min in 1-min increments. Removing and replacing the battery in LL0 allows an immediate incremental dose; after removing and replacing the battery in LL1 and LL2, the entire incremental dose minutes must elapse before a dose can be given.

Patient-activated Doses/Hour (DOSE/HR): 0–12 doses/hr over the previous 60 min; removing battery resets counter.

Clinician-activated Bolus: 0–99.5 mg or 0–20 ml (See Table 2.)

Table 2. Parameter settings for the CADD-PCA Model 5800 series pumps.

MG/ML Conc.	MG Rate Increment	MG/HR Max Rate	MG Dose Increment	MG Max Dose	MG GIVEN Increment	MG Bolus Increment	MG Max Bolus
0.5	0.1	10.0	0.1	3.0	1	0.1	10.0
1	0.1	20.0	0.1	6.0	1	0.1	20.0
2	0.1	40.0	0.1	12.0	1	0.1	40.0
4	0.2	80.0	0.2	24.0	1	0.2	80.0
5	0.5	99.5	0.5	30.0	1	0.5	99.5
10	0.5	99.5	0.5	60.0	2	0.5	99.5
15	1.5	99.0	1.5	90.0	3	1.5	99.0
20	2.0	98.0	2.0	98.0	4	2.0	98.0
25	2.5	97.5	2.5	97.5	5	2.5	97.5
30	3.0	99.0	3.0	99.0	6	3.0	99.0
35	3.5	98.0	3.5	98.0	7	3.5	98.0
40	4.0	96.0	4.0	96.0	8	4.0	96.0
45	4.5	99.0	4.5	99.0	9	4.5	99.0
50	5.0	95.0	5.0	95.0	10	5.0	95.0
55	5.5	99.0	5.5	99.0	11	5.5	99.0
60	6.0	96.0	6.0	96.0	12	6.0	96.0
65	6.5	97.5	6.5	97.5	13	6.5	97.5
70	7.0	98.0	7.0	98.0	14	7.0	98.0
75	7.5	97.5	7.5	97.5	15	7.5	97.5
80	8.0	96.0	8.0	96.0	16	8.0	96.0
85	8.5	93.5	8.5	93.5	17	8.5	93.5
90	9.0	99.0	9.0	99.0	18	9.0	99.0
95	9.5	95.0	9.5	95.0	19	9.5	95.0

MG/ML Conc.	ML Rate Increment	ML/HR Max Rate	ML Dose Increment	ML Max Dose	ML GIVEN Increment	ML Bolus Increment	ML Max Bolus
0	0.1	20.0	0.1	6.0	1	0.1	20.0

Record-keeping Modes

Reservoir-residual Volume (RES VOL): 001–999 in 1-ml increments, rounded up to nearest ml; or RES VOL OFF (RES VOL set to 000).

Patient-activated Doses Given (DOSE GIVEN): 000–999; pump continues recording after 999 but resets counter to 000.

Patient-activated Doses Attempted: 000–999; pump continues recording after 999 but resets counter to 000.

MG GIVEN: 000–999 mg, rounded down to nearest increment (See Table 2); pump continues recording after 999 mg but resets counter to 000.

ML GIVEN: 000–999 ml, rounded down to nearest 1.0 ml; pump continues recording after 999 ml but resets counter to 000.

Pump Characteristics

Volumetric Resolution: 50 microliters per interval.

Continuous Delivery Interval: Dependent upon concentration and continuous delivery settings.

Delivery Accuracy: ± 6%, nominal.

Dimensions

Size: 2.8 cm x 8.9 cm x 16.0 cm (1.1 in x 3.5 in x 6.3 in) including a 50-ml Medication Cassette reservoir.

Weight: 320 grams (11 ounces). The CADD-PCA pump Model 5800R weighs 334 grams (12 ounces).

Alarms

Alarm Functions:

- Pump in Stop mode.
- Low reservoir-residual volume.
- Reservoir-residual volume at 000.
- Low battery warning.
- Battery depleted.
- Hardware and software fault detection.
- High delivery pressure (28 ± 12 psi).
- Conflicting program values.

Power

Power Sources: 9-volt alkaline or lithium battery (Use DURACELL MN 1604 or EVEREADY #522, for example; or ULTRALIFE Lithium U9VL.)

The External Power Source (EPS) system may also be used to power the pump.

Reservoir Capacities

Sizes:

- 50-ml Medication Cassette reservoir.
- 100-ml Medication Cassette reservoir.
- CADD administration set with 60-inch tubing and integral anti-siphon valve.
- CADD administration set with 60-inch tubing, integral anti-siphon valve and bag spike.
- CADD administration set with 80-inch yellow-striped tubing, integral anti-siphon valve and bag spike.
- CADD administration set with 60-inch tubing, add-on anti-siphon valve and bag spike.
- CADD administration set with 60-inch blue-striped TOTM-plasticized tubing, add-on anti-siphon valve and bag spike.
- CADD administration set with 75-inch TOTM-plasticized spiral tubing, 0.2-micron air-eliminating filter, add-on anti-siphon valve and bag spike.
- CADD administration set with 75-inch TOTM-plasticized spiral tubing, 1.2-micron air-eliminating filter, add-on anti-siphon valve and bag spike.

Environmental Requirements

Operating Temperature Range: +2°C to 40°C (35°F to 104°F).

Storage Temperature Range: -40°C to 55°C (-40°F to 131°F).

Humidity Range: 10% to 90% relative humidity noncondensing.

5 CADD-PLUS® Pump Model 5400

Delivery Modes

CADD-PLUS pumps may be used to provide continuous or intermittent drug delivery. CADD-PLUS pumps are intended for intravenous, subcutaneous, or intra-arterial drug delivery (excluding insulin). In the continuous delivery mode, the pump delivers medication at a constant rate; in the intermittent delivery mode, it delivers medication at regular, preset intervals. (See Figure 8.) It is possible to program a second rate (KVO) between periods or before the initial period (DELAY START). The pump's flexibility allows it to be used in a variety of settings. Figure 9 shows a diagram of the CADD-PLUS pump.

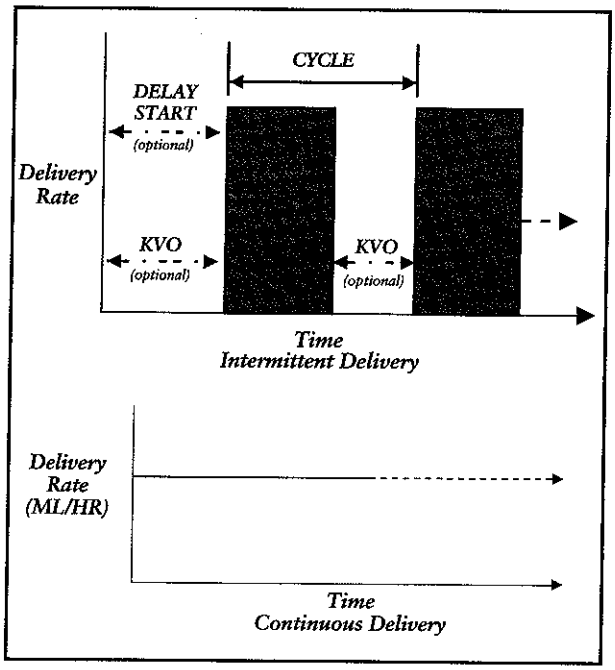


Figure 8. CADD-PLUS Model 5400 pump delivery profile.

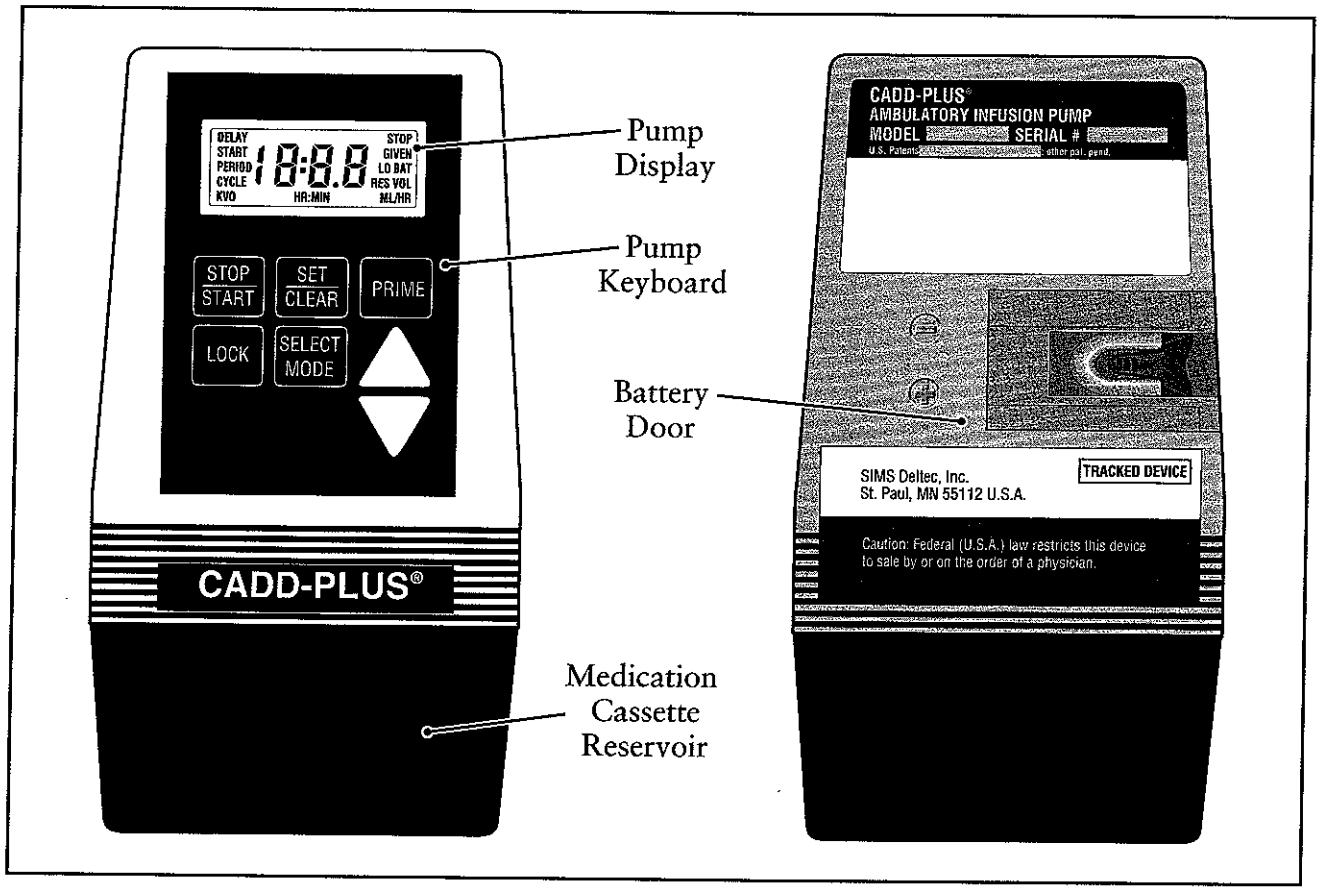


Figure 9. Front and back views of the CADD-PLUS Model 5400 pump.

Technical Specifications (Nominal)

Continuous Programming Modes

RATE: 00.0–75.0 ml/hr in 00.1-ml/hr increments.

Continuous Record-keeping Modes

Reservoir-residual Volume (RES VOL): 001–1500 ml in 1-ml increments, rounded up to nearest ml; or RES VOL OFF (RES VOL set to 000).

ML GIVEN: 000–999 ml in 1-ml increments, rounded down to the nearest ml; pump continues recording after 999 ml but resets counter to 000.

Intermittent Programming Modes

Infusion ML: 0.0–150.0 ml in 00.1-ml increments.

Infusion PERIOD: 10 min–12 hrs in 10-min increments.

Infusion CYCLE: 20 min–12 hr:10 min in 10-min increments; or, 24 hrs for a 24-hour CYCLE.

KVO ML/HR: 0.2–10.0 ml/hr, in 0.1-ml/hr increments; and 0.0 when not using the KVO.

DELAY START: 10 min–12 hr in 10-min increments.

Intermittent Record-keeping Modes

Reservoir-residual Volume (RES VOL): 001–1500 ml in 1-ml increments, rounded up to nearest ml; or RES VOL OFF (RES VOL set to 000).

CYCLE GIVEN: 0 min–12 hr:10 min in 1-min increments; and 0 hrs–24 hrs, in 1-hr increments, when CYCLE is programmed for 24-hrs.

ML GIVEN: 000–999 ml in 1-ml increments, rounded down to the nearest ml; pump continues recording after 999 ml but resets counter to 000.

Pump Characteristics

Volumetric Resolution: 50 microliters per interval.

Delivery Interval: Dependent on rate.

Delivery Accuracy: ± 6%, nominal.

Dimensions

Size: 2.8 cm x 8.9 cm x 16.0 cm (1.1 in x 3.5 in x 6.3 in) including a 50-ml Medication Cassette reservoir.

Weight: 320 grams (11 ounces).

Alarms

Alarm Functions:

- Pump in Stop mode.
- Low reservoir-residual volume.
- Reservoir-residual volume at 000.
- Low battery warning.
- Battery depleted.
- Hardware and software fault detection.
- High delivery pressure (28 ± 12 PSI).
- Conflicting program values.

Power

Power Sources: 9-volt alkaline or lithium battery (use DURACELL MN 1604 or EVEREADY #522, for example; or ULTRALIFE Lithium U9VL).

The External Power Source (EPS) system may also be used to power the pump.

Reservoir Capacities

Sizes:

- 50-ml Medication Cassette reservoir.
- 100-ml Medication Cassette reservoir.
- CADD administration set with 60-inch tubing and integral anti-siphon valve.
- CADD administration set with 60-inch tubing, integral anti-siphon valve and bag spike.
- CADD administration set with 80-inch yellow-striped tubing, integral anti-siphon valve and bag spike.
- CADD administration set with 60-inch tubing, add-on anti-siphon valve and bag spike.
- CADD administration set with 60-inch blue-striped TOTM-plasticized tubing, add-on anti-siphon valve and bag spike.
- CADD administration set with 75-inch TOTM-plasticized spiral tubing, 0.2-micron air-eliminating filter, add-on anti-siphon valve and bag spike.
- CADD administration set with 75-inch TOTM-plasticized spiral tubing, 1.2-micron air-eliminating filter, add-on anti-siphon valve and bag spike.

Environmental Requirements

Operating Temperature Range: +2°C to 40°C (35°F to 104°F).

Storage Temperature Range: -40°C to 55°C (-40°F to 131°F).

Humidity Range: 10% to 90% relative humidity noncondensing.

6 CADD-TPN® Pump Model 5700

Delivery Modes

The CADD-TPN pump delivers nutritional solutions at continuous infusion rates, which may include a programmable feature called "tapering." With tapering, infusion rates are gradually increased at the beginning of an infusion period, and/or are gradually decreased at the end of an infusion period. (See Figure 10.) The pump's flexibility allows it to be used in a variety of settings. Figure 11 shows a diagram of the CADD-TPN pump.

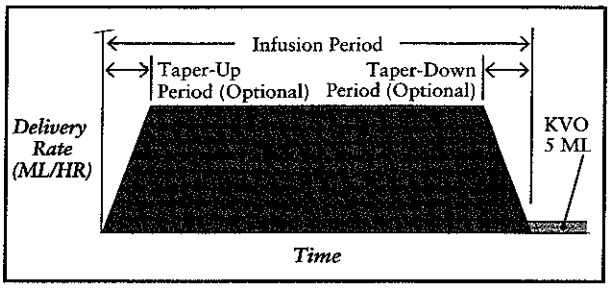


Figure 10. CADD-TPN Model 5700 pump delivery profile.

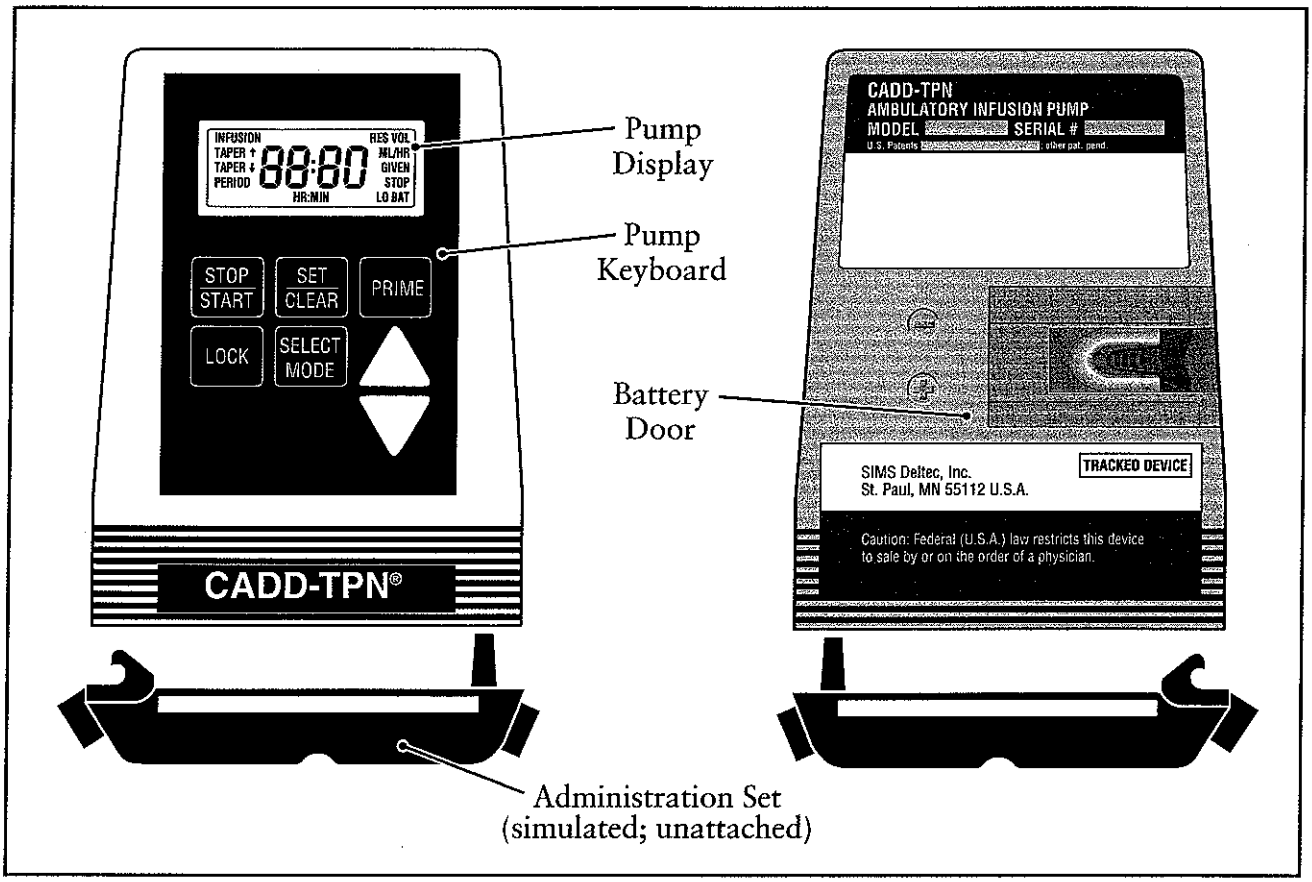


Figure 11. Front and back views of the CADD-TPN Model 5700 pump.

Technical Specifications (Nominal)

Delivery modes

Continuous delivery; and

Continuous delivery with tapering.

Programming Modes

Reservoir-Residual Volume (RES VOL): 0000 (OFF), 10-9990 ml; 10-ml increments

Infusion ML: 10–9990 ml; 10-ml increments

Infusion PERIOD: 10 min–99 hrs, 50 min; 10-min increments

Taper-up Period (TAPER ↑): 0–99 hrs, 40 min

Taper-down Period (TAPER ↓): 0–99 hrs, 40 min

Record-keeping Modes

Reservoir-residual Volume (RES VOL): 0010–9990 ml in 10 ml increments, rounded up to the nearest 10 ml; or, RES VOL is set to 0000, and OFF appears on the display.

ML GIVEN: 0000–9990 ml, rounded down to the nearest 10 ml. The pump continues recording after reaching 9990 milliliters but resets the counter to 0000.

Delivery Parameters

Continuous Rate: Using power pack: 10–400 ml/hr; Using 9-volt battery: 10–250 ml/hr

KVO Rate: 5 ml/hr

Pump Characteristics

Volumetric Resolution: Approximately 250 microliters per interval.

Delivery Interval: Dependent on rate.

Delivery Accuracy: ± 8%, nominal.

Dimensions

Size: 2.8 cm x 8.9 cm x 13.3 cm (1.1 in x 3.5 in x 5.25 in), including set plate.

Weight: 320 grams (11 ounces).

Alarms

Alarm Functions:

- Pump in Stop mode.
- Low fluid container volume.
- Reservoir-residual volume at 0000.
- Low battery warning.
- Battery depleted.
- Hardware and software fault detection.
- High delivery pressure (22 ± 12 PSI).
- Conflicting program values.
- Infusion period completed.

Power

Power Sources: 9-volt alkaline or lithium battery (use DURACELL MN 1604 or EVEREADY #522, for example; or ULTRALIFE Lithium U9VL).

The External Power Source (EPS) system may also be used to power the pump.

Administration Set

For use with nonvented, flexible, plastic bags.

Equipped with air-eliminating filters: 0.2 µ administration set; and 1.2 µ administration set.

Environmental Requirements

Operating Temperature Range: +2°C to 40°C (35°F to 104°F).

Storage Temperature Range: -30°C to 50°C (-22°F to 122°F).

Humidity Range: 10% to 90% relative humidity noncondensing.

Air-eliminating Filters

Deltec CADD-TPN administration sets use filters that are designed to eliminate air during routine IV therapy.

The filter contains two membranes that are supported by a hard plastic shell: (1) hydrophilic (a membrane capable of being moistened); and (2) hydrophobic (a membrane incapable of being moistened). (See Figure 12.)

The hydrophilic membrane must be saturated to restrict air from passing through it. The hydrophobic membrane (nonmoistened) will allow the passage of air, but it will restrict the passage of liquids.

Deltec provides filters with two sizes of porosity in CADD-TPN administration sets, 0.2 and 1.2 micron.

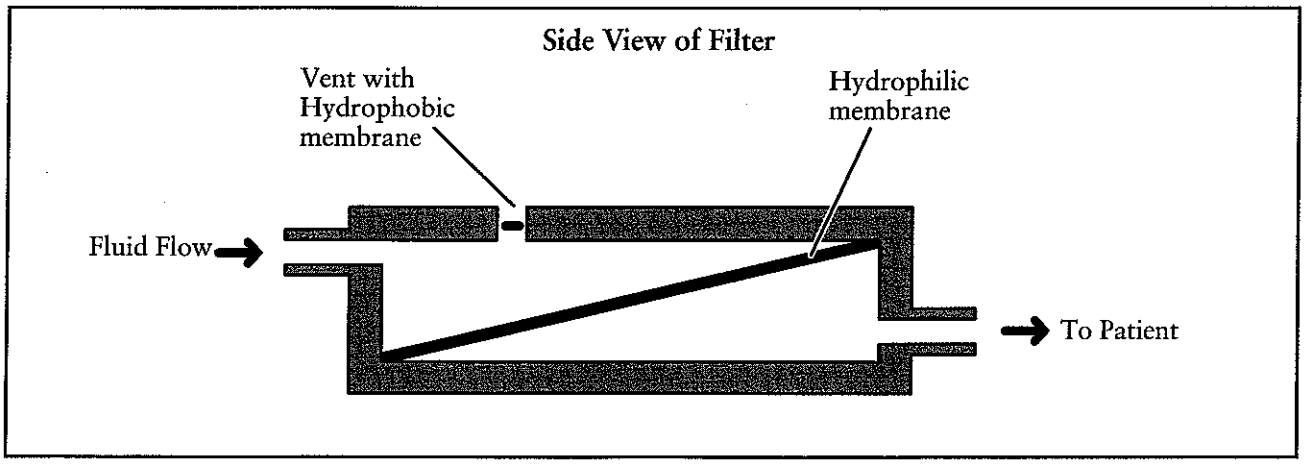


Figure 12. Schematic representation of air-eliminating filter (position of components may vary).

7 Batteries

Battery Compatibility

Recommended Batteries

Alkaline batteries are recommended for use in CADD pumps. Lithium batteries may be used in selected CADD pumps. **Carbon-zinc, mercury, nickel-cadmium, or zinc-air 9-volt batteries should not be used.** Table 4 summarizes the types of batteries recommended for each CADD pump model. The EPS system can be used with all CADD pumps.

Battery Life

CADD pumps have been designed to provide optimal battery life. The expected battery life in Deltec CADD-1, CADD-PCA, CADD-PLUS, and CADD-TPN infusion pumps depends on the following factors:

- Programmed delivery rate.
- Operating temperatures.
- Battery type and brand.
- Battery age.

DURACELL Alkaline Battery Life

Tables 5 and 6 may be used to approximate typical alkaline battery life when an alkaline battery is used in CADD pumps with different delivery rates. As expected, battery life decreases as the delivery rate increases. These tables are based on laboratory tests using fresh DURACELL alkaline batteries in CADD pumps, while the pumps were operating at room temperature.

Actual battery life may be significantly shorter, depending on the operating temperature and the storage conditions of the battery.

Battery life is shortened significantly at very low operating temperatures. For example, at 0°C (32°F), an alkaline battery will yield approximately 30% of its normal capacity.

Alkaline batteries do not need to be stored in a refrigerator. After four years of storage at 21°C (70°F), an alkaline battery retains approximately 86% of its original capacity. Battery life will be shorter if the battery is stored above room temperature. An alkaline battery stored at 43°C (110°F) will be down to approximately 80% of its capacity within one year.

Recommended storage conditions are 10°C to 25°C (50°F to 77°F) with no more than 65% relative humidity noncondensing.

Table 4. Battery compatibility.

Pump Model	9-volt Alkaline Battery	9-volt Lithium Battery	EPS System
CADD-1 Models 5100, 5100 HF, 5101 HF	Yes	No	Yes
CADD-1 Model 5100 HFX	Yes	Yes	Yes
CADD-PCA Models 5200, 5200P, 5200 PXC	Yes	No	Yes
CADD-PCA Models 5800, 5800R	Yes	Yes	Yes
CADD-PLUS Model 5400	Yes	Yes	Yes
CADD-TPN Model 5700	Yes	Yes	Yes

Table 5. Typical battery life for alkaline-type batteries used with CADD pumps (other than the CADD-TPN pump).†

Delivery Rate	Alkaline Battery Life	Total Volume Delivered (per Battery)
10 ml/day	12–14 days	120–140 ml
20 ml/day	10–14 days	200–280 ml
50 ml/day	6–10 days	300–500 ml
100 ml/day	4–6 days	400–650 ml
150 ml/day	3–4 days	450–700 ml
200 ml/day	2–3 days	500–750 ml
10 ml/hr	50–80 hours	500–800 ml
20 ml/hr	32–48 hrs	640–960 ml
50 ml/hr	14–24 hrs	750–1200 ml
75 ml/hr	9–18 hrs	675–1350 ml
90 ml/hr	10–15 hrs	900–1350 ml

† This table is based on laboratory tests conducted at room temperature using fresh DURACELL alkaline batteries. Actual battery life will vary, depending on the brand of battery, battery shelf life, and temperature conditions.

Table 6. Typical battery life for alkaline-type batteries with the CADD-TPN pump.†

Delivery Rate	Alkaline Battery Life	Total Volume Delivered (per Battery)
50 ml/hr	50–63 hours	2500–3150 ml
100 ml/hr	30–37 hours	3000–3700 ml
150 ml/hr	21–28 hours	3150–4200 ml
200 ml/hr	14–20 hours	2800–4000 ml
250 ml/hr	10–15 hours	2500–3750 ml

† This table is based on laboratory tests conducted at room temperature using fresh DURACELL alkaline batteries. Actual battery life will vary, depending on the brand of battery, battery shelf life, and temperature conditions.

ULTRALIFE Lithium Battery Life

Tables 7 and 8 may be used to approximate typical lithium battery life when a lithium battery is used in CADD pumps with different delivery rates. As expected, battery life decreases as the delivery rate increases. These tables are based on laboratory tests using fresh ULTRALIFE lithium batteries in CADD pumps, while the pumps were operating at room temperature.

Actual battery life may be significantly shorter, depending on the operating temperature and the storage conditions of the battery. Lithium battery life is dependent upon the temperature and relative humidity of storage. Recommended storage conditions are less than 20°C (68°F) with a desiccant to ensure less than 10% relative humidity.

External Power Source (EPS) System Power Pack Life

Tables 7, 8 and 9 may be used to approximate the power pack capacity when a power pack is ready to use with CADD pumps.

Table 7. Typical battery life for ULTRALIFE lithium batteries or EPS system power pack used with CADD pumps (other than the CADD-TPN pump).†

Delivery Rate	Lithium Battery Life or EPS Power Pack Capacity	Total Volume Delivered (per Battery)
1 ml/hr	29-40 days	700-960 ml
5 ml/hr	11-15 days	1310-1800 ml
10 ml/hr	8-10 days	1920-2400 ml
20 ml/hr	5-7 days	2340-3210 ml
50 ml/hr	27-37 hrs/61-100 hours (EPS)	1360-1870 ml/3000-5000 ml (EPS)
75 ml/hr	24-34 hrs/41-68 hours (EPS)	1840-2525 ml/3000-5000 ml (EPS)

Table 8. Typical battery life for ULTRALIFE lithium batteries or EPS system power pack with the CADD-TPN pump.†

Delivery Rate	Lithium Battery Life	Total Volume Delivered (per Battery)
50 ml/hr	110-200 hours	5500-10000 ml
100 ml/hr	60-100 hours	6000-10000 ml
150 ml/hr	43-66 hours	6500-10000 ml
200 ml/hr	35-55 hours	7000-11000 ml
250 ml/hr	32-44 hours	8000-11000 ml

Table 9. Typical battery life for EPS system power pack with the CADD-TPN pump.

Delivery Rate	EPS Power Pack Capacity	Total Volume Delivered (per Battery Charge)
50 ml/hr	160-300 hours	7000-15000 ml
100 ml/hr	82-160 hours	7500-16000 ml
150 ml/hr	50-110 hours	7500-17500 ml
200 ml/hr	38-83 hours	7500-16000 ml
250 ml/hr	30-67 hours	7500-16000 ml
300 ml/hr	25-56 hours	7500-16000 ml
350 ml/hr	22-48 hours	7500-16000 ml
400 ml/hr	19-42 hours	7500-16000 ml

† This table is based on laboratory tests conducted at room temperature using fresh ULTRALIFE lithium batteries. Actual battery life depends upon the brand of battery selected, the particular battery selected, battery shelf life, and temperature conditions. Deltec's testing indicates a large variability in battery life.

8 Construction

The pump housing is made of a special plastic designed to reduce interference from electromagnetic fields and to dissipate electrostatic discharge. It is composed of two sections: the front and back housing. The pump housings are sealed to ensure that the pump is water resistant. **The battery compartment is not water resistant.**

NOTE:

CADD ambulatory infusion pumps are water resistant, but are not waterproof.

The battery compartment is accessed through a removable door in the back housing. Within the battery compartment is space for the battery and the two battery contacts.

The Medication Cassette reservoir, CADD administration set with anti-siphon valve, or CADD-TPN administration set is attached to the bottom of the pump by inserting the two hooks on the reservoir into the mating hinge pins of the pump. The pump and the Medication Cassette reservoir, CADD administration set with anti-siphon valve, or CADD-TPN administration set are then placed in an upright position on a firm, flat surface. The Medication Cassette reservoir, CADD administration set with anti-siphon valve, or CADD-TPN administration set can be locked in place by inserting a coin in the slot on the pump's locking button, pushing the button in, and turning the button one-quarter turn counter-clockwise (CADD-1 Models 5100, 5100 HF, and 5100 HFX; CADD-PLUS Model 5400; and CADD-TPN Model 5700); or, by using a key in the same manner (CADD-PCA Models 5200, 5200P, 5200 PXC, 5800 and 5800R; and CADD-1 Model 5101 HF).

NOTE:

The Medication Cassette reservoir, CADD administration set with anti-siphon valve, and CADD-TPN administration set are intended for single use only.

The keyboard, located on the front housing, is composed of seven (CADD-1, CADD-PLUS, and CADD-TPN pumps) or eight (CADD-PCA pump) membrane switches and is sealed against moisture. All of the keys contain domes to provide a tactile feel when the key is pressed. The keyboard keys are sensed by the pump's microprocessor.

The CADD-PCA Model 5800R pump incorporates a REMOTE DOSE cord that enables the patient to use either of two options when accessing the DOSE function: (1) the REMOTE DOSE button; or (2) the DOSE key. (See Figure 7.) Either option will achieve the same effect.

The custom Liquid Crystal Display (LCD), also located on the front housing, shows the pump status and programmed settings. The annunciators to be displayed are selected by the pump's microprocessor, according to status conditions and keyboard entries.

The microprocessor and other circuitry which control the pump are located on two printed circuit boards. The microprocessor board contains the Central Processing Unit (CPU) and its associated circuitry. The LCD board contains the Liquid Crystal Display with its associated circuitry, the motor driver circuitry, and other miscellaneous circuitry.

The pumping mechanism subassembly contains the motor, gear train, camshaft, valves, expulsor, sensing disk, infrared light source, and infrared detector. Via the motor driver circuitry, the pump's microprocessor controls motor rotation.

All connections between the printed circuit boards are soldered, to maintain reliability. The two printed circuit boards are connected by a ribbon connector which is soldered at both ends. The keyboard is connected to the LCD board via a flex circuit tail which is soldered to the LCD board. Discrete soldered wires connect the pumping mechanism, motor, and sensors to the printed circuit boards.

9 Theory of Operation

Keyboard Circuitry

CADD pumps are controlled by a microprocessor. The actions of the microprocessor are controlled by a program, which is contained in the EPROM.

Commands are issued to the microprocessor from the user via the seven (CADD-1, CADD-PLUS, and CADD-TPN) or eight (CADD-PCA) keys on the keyboard; or, in the case of the CADD-PCA 5800R, keys on the keyboard and the REMOTE DOSE cord. These keys are connected in a four by four matrix. The X and Y lines of the matrix are continuously scanned by the keyboard encoder. When one of the four X lines is connected to one of the four Y lines by pressing a key, a keyboard interrupt message is sent to the microprocessor by the keyboard encoder. In response, the microprocessor reads the four-bit code corresponding to the key pressed from the keyboard encoder. A unique code corresponds to each key. Even if more than one key is pressed simultaneously, the code for only one of the keys is presented to the microprocessor.

Data Memory EEPROM

The settings of the pump's delivery and record-keeping parameters are stored by the microprocessor in an Electrically Erasable Programmable Read Only Memory (EEPROM). Data to and from the memory is presented serially. Whenever the microprocessor uses data from the EEPROM the data is checked for validity.

Time Base Circuitry

An accurate 163.84 kHz timebase is provided by a quartz crystal oscillator. The 163.84 kHz signal is connected to the microprocessor, where it is frequency-divided to access the program memory EPROM at a cycle rate of 32.77 kHz.

LCD Display Circuitry

The high-impedance, low-power, special drive signals for the liquid crystal display are provided by the LCD-driver. Each annunciator and each numeric segment is driven by a separate connection to the LCD-driver. When an annunciator or numeric segment AC signal is 180° out of phase with the display backplane, the associated area on the LCD will be dark. Each numeric character on the LCD is formed from darkening combinations of seven segments for each of the four (CADD-TPN) or three (CADD-1, CADD-PLUS and CADD-PCA) numeric characters. Each annunciator is, in effect, a single segment which has been printed on the LCD to form an entire word or phrase, such as LO BAT or RES VOL. Commands to display characters or annunciators are issued serially to the LCD-driver by the microprocessor via output port bits. Once the location and character to be displayed has been sent to the LCD-driver by the microprocessor, the LCD-driver automatically displays the character until the microprocessor issues new commands to change the display.

Gate Array Circuitry

Memory address decoding and the audible alarm oscillator circuitry are located in the gate array. The audible alarm oscillator drives a piezoelectric disk which flexes or bends in resonance with the 1550 Hz output signal of the oscillator. When the disk is mounted on the plastic pump housing, the sound-level is enhanced. The audible alarm oscillator can be triggered by the microprocessor or from the processor watchdog one-shot.

Circuitry for the microprocessor power-up reset is also located in the gate array and associated circuitry. The components form an RC network to cover the 1920 cycle power-up delay of the microprocessor.

Safety Timeout Circuitry

The one-shot is a safety timeout circuit which is normally kept from timing out by regular resets from the microprocessor via an output port bit. If the microprocessor program does not reset the one-shot, the audible alarm is triggered and the microprocessor is held in reset.

Motor Driver Circuitry

The motor driver circuit is composed of the one-shot, power FETs, and various passive components. When the microprocessor issues a signal from an output port bit, a one-shot triggers. The motor receives power and begins to rotate. When the infrared detector has signalled the microprocessor that the motor has rotated, the microprocessor terminates a signal and the output of the one-shot goes low, taking power from the motor and then applying an electrical brake to the motor which stops its rotation very accurately.

If the microprocessor fails to turn off a signal, the one-shot will time out after 4.7 seconds, thus turning off the motor. In addition, if the one-shot fails to time out after 4.7 seconds, the motor driver circuitry itself will time out after 7 seconds and stop the motor.

Rotation of the motor is sensed by the microprocessor via an infrared-sensitive photo detector. An infrared light source is mounted so that its light beam illuminates the infrared detector. An opaque flag is mounted concentrically to the camshaft and rotates with it between the infrared light source and detector. When the flag interrupts the light beam, the output of the detector is sensed by the microprocessor via an input port bit. Power to the infrared LED light source is controlled by the motor driver circuit and is off when the motor is not running to conserve battery life.

In the microprocessor software, multiple checks are made on motion of the camshaft. When the motor is commanded to start, the infrared sensor must show that one revolution has occurred within five seconds and that the motor has stopped when one rotation was completed. In addition, no camshaft rotation can take place when the motor has not been commanded to run.

Power Circuitry

Power for the pump is normally supplied by a 9-volt alkaline battery, 9-volt lithium battery, External Power Source system Ni-Cad power pack, or power pack with AC adapter. These types of batteries have a fairly low internal resistance over their discharge range, which will keep power supply noise low. Other types of batteries, such as carbon-zinc, exhibit high internal resistance, especially near depletion. A voltage drop across the internal resistance occurs when current is drawn by the motor during pump activations. This current is demanded in short pulses when the motor is first turned on and generates large spikes in the battery voltage. This noise can cause the low battery detection circuit to shut down the pump.

The motor driver circuit power is taken directly from the battery, but the microprocessor and its associated circuitry requires closely regulated and filtered 5-volt power which is supplied from the micropower voltage regulator. This regulator will supply 5-volt power until its input voltage is approximately 5.8 volts. After that point, the output of the regulator will follow the input voltage down.

Low Voltage Detection Circuitry

Low voltage detection is performed by the dual low voltage detector. When the battery voltage reaches between 6.05 and 6.68 volts, output of the low voltage detector is sensed by the microprocessor via an input port bit and the microprocessor causes the LO BAT annunciator to appear on the LCD via an output port bit. (See Table 9.)

To prevent the output of the low battery detector from oscillating when the battery voltage is near the trip point, hysteresis is employed. Due to the hysteresis, once the trip point has been reached, the output of the low voltage detector will not reset again until the input voltage reaches approximately 0.5 volts above the trip point.

When the battery voltage reaches between 5.70 and 6.40 volts, the other output of the low voltage detector disables the motor driver, which prevents any motor movement due to loss of control caused by the very low battery voltage. (See Table 9.) In addition, the microprocessor is held in reset and the audible alarm is turned on.

This ensures that the shutdown alarm does not occur at a voltage which does not allow the low battery alarm to activate first, and to allow an adequate low battery warning. The setpoint resistors of the voltage detector are selected so that the difference between low battery and shutdown (battery depleted) is between 0.15 and 0.50 volts.

Pumping Mechanism

The pumping mechanism is linear peristaltic with two active valves. Pumping occurs when the expulsor presses on the reservoir pump tubing in sequence with the inlet and outlet valves. At rest, the outlet valve is pressing down fully on the tubing and the expulsor and inlet valve are retracted. (See Figure 13.)

When the microprocessor commands the mechanism to pump, the camshaft begins to rotate, thus controlling the following pump cycle:

1. The inlet valve closes.
2. In synchrony with the expulsor moving down to compress the tubing, the outlet valve opens, expelling 50 µl of fluid toward the patient (approximately 250 µl with the CADD-TPN pump).
3. The outlet valve closes.
4. The inlet valve opens as the expulsor is retracted, causing fluid from the reservoir to again fill the pump tubing segment.
5. The camshaft rotation stops after one revolution and the cycle is completed.

Table 9. CADD Pump LO BAT Conditions.

Voltage Trip Point	CADD Pump Status
> 6.68 V	No alarm
6.05–6.68 V*	Transition to low battery condition; indicator blinks; 3 beeps every 5 min†
5.70–6.40 V*	Transition to low battery condition; indicator appears on LCD; continuous alarm††

* The trip-point differential is between 0.15 and 0.50 volts.
† The pump emits 3 beeps every 5 minutes, and the LO BAT indicator blinks on the pump's display, indicating that the battery power is low; but the pump is operable.
†† The pump emits a continuous, variable-tone alarm, and LO BAT remains on the display but does not blink; the battery power is too low to operate the pump; and the pump operation has stopped.

Pumping Characteristics

CADD-1, CADD-PCA, and CADD-PLUS Pumps

If the fluid path to the patient becomes blocked, the pump tubing will expand as pumping occurs. When there has been an amount of inflation corresponding to 190 ± 80 kPa (1.9 ± 0.8 bar, 28 ± 12 psi), the occlusion detector switch becomes closed, whereupon the microprocessor stops the pump mechanism and issues visual and audible alarms. Thus the maximum pressure which can be developed is 270 kPa (2.7 bar, 40 psi).

To deliver the amount of drug specified by the parameter settings, the pump's microprocessor causes the pump mechanism to deliver 50 µl fluid "pulses" timed according to the desired rate. Thus, to deliver 20 ml/24 hrs, for example, the microprocessor solves these equations:

Mechanism activations per 24 hrs
- = 20 ml per 24 hrs/0.05 ml per activation
- = 20/0.05
- = 400

Time (seconds) between activations
- = 86400 sec per 24 hrs/number of activations per 24 hrs
- = 86400/400
- = 216

The microprocessor uses its timer circuits to accurately time the 216 seconds (in this example) between mechanism activations. The timebase accuracy is ultimately determined by the 163.84 kHz quartz crystal oscillator.

CADD-TPN Pump

If the fluid path to the patient becomes blocked, the pump tubing will inflate as pumping occurs. When there has been an amount of inflation corresponding to 150 ± 80 kPa (1.5 ± 0.8 bar, 22 ± 12 psi), the occlusion detector switch will become closed, whereupon the microprocessor will stop the pump mechanism and issue visual and audible alarms. Thus the maximum pressure which can be developed is 230 kPa (2.3 bar, 34 psi).

To deliver the amount of fluid specified by the parameter settings, the pump's microprocessor causes the pump mechanism to deliver 250 µl fluid "pulses" timed according to the desired rate. Thus, to deliver 2000 ml/10 hrs, for example, the microprocessor solves these equations:

Mechanism activations per 10 hr
- = 2000 ml per 10 hrs/0.25 ml per activation
- = 2000/0.25
- = 8000

Time (seconds) between activations
- = 36000 sec per 10 hrs/number of activations per 10 hrs
- = 36000/8000
- = 4.5

The calculations shown above are an approximation. Compensation software is used to account for minor pump differences.

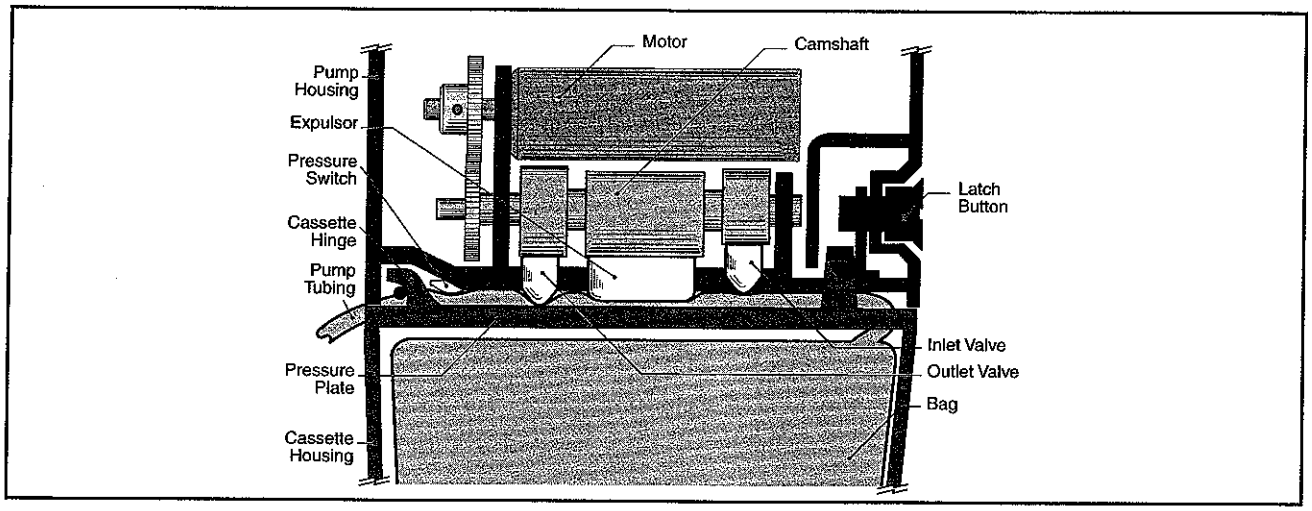


Figure 13. A simulated pumping mechanism in a CADD pump.

10 Safety Features and Fault Detection

Hardware Safety Features

Key hardware safety features include a watchdog timer circuit, motor driver and motor watchdog circuits, and a voltage detector circuit. Each safety circuit performs a unique function to insure the over-all safety of the device. (See Figure 14.)

Watchdog Timer Circuit

The microprocessor must send an appropriate signal to the watchdog circuit at least once per 2 seconds. If the microprocessor does not, the watchdog circuit will time out and shut down the pump controller.

The watchdog circuit is a CMOS one-shot. It is configured to operate in the "retriggerable" mode. If the one-shot times out, the Q and not-Q lines change state. The Q line, going low, will put the microprocessor into reset. The not-Q line, going high, will force the audible alarm on. Once the one-shot times out, there is no way for the one-shot to be retriggered without removing and reinserting the battery.

Motor Driver/Motor Watchdog Circuit

The motor control circuitry is designed to prevent the pumping mechanism from running continuously. Under normal conditions the microprocessor turns on the motor by triggering a one-shot which in turn applies power to the motor. This one-shot has a 4.7 second time out. If, for some reason, the pump controller did not shut the motor off after 4.7 seconds the one-shot would shut off automatically.

The motor control circuit also incorporates additional circuitry which continuously monitors the voltage being applied to the motor. If under any circumstance voltage is applied to the motor for more than 7 seconds, this circuit will automatically cut power to the motor. In this case, the motor will be disabled in a manner different from the method in which the one-shot turns off the motor.

A means has been provided for the microprocessor to sense the voltage applied to the motor. (See "Software Safety Features" on page 25 of this manual.)

Voltage Detector Circuit

The low voltage detection circuitry works in two stages. First, when the battery voltage begins to get low, a signal is sent to the microprocessor. Second, the microprocessor then sounds a periodic alarm and flashes the LO BAT annunciator on the LCD display.

When the battery voltage drops to the point at which reliable operation of the pump controller can no longer be guaranteed, the following action will take place: the motor circuit is disabled by a method independent from all others; the microprocessor is forced into reset; and a continuous audible alarm and the LO BAT annunciator are turned on. Once the pump controller goes into low battery shutdown, only replacing the old battery with a fresh one will clear the condition.

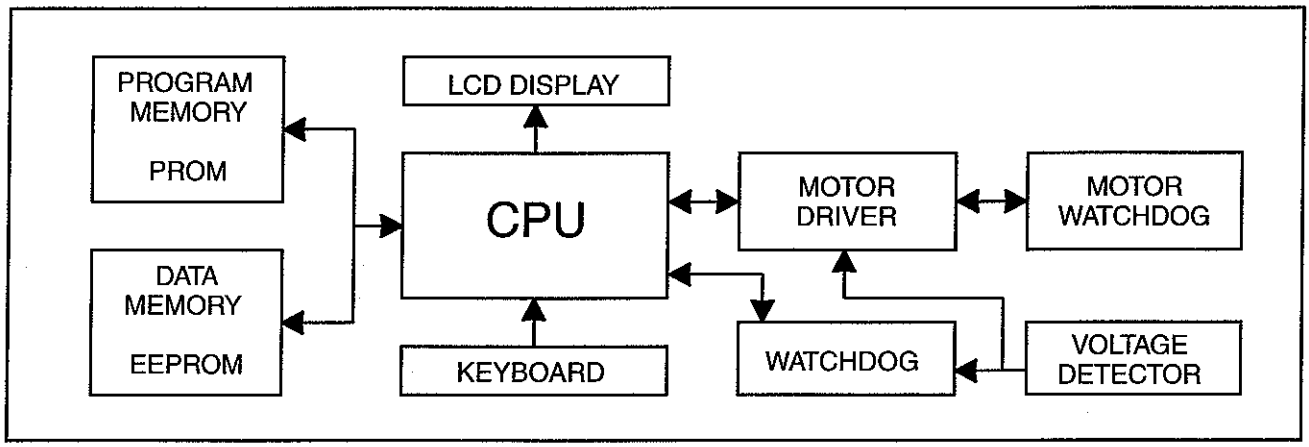


Figure 14. CADD pump hardware block diagram.

Software Safety Features

Hardware-related Software Safety Features

Program Memory (PROM) Check

At power up, and at regular intervals thereafter, the program memory is tested by the software. The content of the memory is added and then compared against a checksum. If they do not match, the software will turn on a continuous, audible alarm and stop all drug delivery.

Data Memory (EEPROM) Check

At power up, the data memory is tested by the software. The content of the memory is checked, address by address, for the proper data. Proper data consists of 12 data bits and 4 checksum bits at each address. If any bad data is found, the software automatically reprograms the data memory to the default (safe) settings and stops all drug delivery. The user is then shown the new data and, at the same time, a series of audible alarms will sound.

Working Memory (RAM) Check

At power up, the random access memory is checked. A special bit pattern is written to and read from each address in the RAM. If any bad data is found, the software will turn on a continuous, audible alarm and stop all drug delivery.

Motor Circuit Check

At power up and every second thereafter, the motor circuit is checked to ensure no power is being applied to the motor; except, of course, when the motor is actually on. If the software detects power being applied to the motor, it will sound a constant audible alarm and will no longer attempt to deliver medication.

During every pump activation, the software checks to see whether the motor completes one activation. If the motor fails to turn, or fails to complete a cycle, the software will turn on a continuous, audible alarm, and the pump controller will no longer attempt to deliver the medication.

Keyboard Encoder Check

Every time the software receives data from the keyboard encoder, it is checked. If the data is not within the correct range, a constant audible alarm is turned on, and the pump controller will no longer attempt to deliver drug.

Data Handling Software Safety Features

Data Stored in RAM

All data stored in RAM and used in some way to control the delivery of drug is stored redundantly or with a checksum. Before the data is used, its validity is checked. If a mismatch or checksum error is found, a continuous audible alarm is turned on and the pump controller will no longer attempt to deliver the medication. In addition, data stored in RAM that has a duplicate in EEPROM is updated from EEPROM to RAM every 5 minutes.

Data Stored in EEPROM

All data stored in EEPROM is checked before it is used. If the data is found to be bad (improper checksum) a continuous audible alarm is turned on and the pump controller will no longer attempt to deliver the medication.

Data Used in Calculations

When a calculation is made which is used in determining how much drug to deliver a check is made on the result of the calculation. If the result is not within proper limits, a continuous audible alarm is turned on and the pump controller will no longer attempt to deliver the medication.

Timer Data Registers

The data stored in the timer control register is checked every second for accuracy. If the data is not correct a continuous audible alarm is turned on and the pump controller will no longer attempt to deliver the medication.

Interrupt Service Routines

The software is organized around three interrupt service routines. When the battery is inserted, the power-up module initializes the pump and performs safety checks, after which it waits for a timer or keyboard interrupt. A keyboard interrupt occurs whenever a key is pressed, and the service routine responds according to the pressed key.

A timer interrupt occurs every second, and the service routine maintains all time-dependent functions. (See Figure 15.)

The software routines are functionally grouped into software modules. In addition to the modules that service the interrupts, there are also modules that contain routines to control the LCD, pump motor, EEPROM, and delivery rate calculations. (See Figure 16.)

KEYBOARD INTERRUPT SERVICE MODULE	POWER-UP MODULE	TIMER INTERRUPT SERVICE MODULE
Service keyboard input as appropriate for keys pressed and current pump status. (Note that the CADD-PCA Model 5800R pump has a button on the REMOTE DOSE cord as well as eight keys on the keyboard.)	Initialize system. Perform safety checks. Wait for timer or keyboard interrupt.	Perform periodic safety checks. Maintain pump interval timing. Maintain time-dependent alarms. Maintain flashing annunciators.

Figure 15. Interrupt service routines.

DISPLAY ROUTINES	MATH ROUTINES	CALCULATION ROUTINES
Handles various methods of displaying and toggling LCD segments.	Contains arithmetic routines. Divide. BCD to binary.	Contains routines to calculate pump parameters. Pumping interval. Bolus amounts.

EEPROM ROUTINES	PUMP ROUTINES	MISCELLANEOUS ROUTINES
Contains routines to interface with EEPROM. Includes safety checks on every read.	Contains routines associated with pumping. Includes RES VOL, GIVEN, and HI P.	Routines to do various tasks: walking digits, on/off, display, beep, and limit check.

Figure 16. CADD pump software routines.

Hardware and Software Fault Detection

Overview

If a CADD pump displays an error code, a hardware or software fault has been detected by the microprocessor, and the pump should be returned for servicing.

When hardware or software faults are detected by the microprocessor, the pump operation stops, and a continuous, audible alarm will be activated. An error message will be displayed. On the next power up, an error code will again be displayed with the software level. The pump will be in Lock Level 2. "OFF" will appear on the RES VOL display, and all other programmed functions will have default values. (See each pump's operator manual for specific defaults.)

Order of Error Code Events

1. There is an continuous, audible alarm and the display will read EEE on the following pumps: CADD-1, Models 5100, 5100 HF, and 5101 HF; and CADD-PCA Models 5200, 5200P, and 5200 PXC.

   There is a continuous, two-tone, audible alarm and the display will read EXX on the following pumps: CADD-1 Model 5100 HFX, CADD-PCA Models 5800 and 5800R, CADD-PLUS Model 5400, and CADD-TPN Model 5700. (Note: "XX" is a 2-digit code.)
2. To silence the error code alarm, remove the battery.
3. At the next power-up and each subsequent power-up thereafter (until the pump is serviced), the microprocessor will write a software revision plus an error code in the EEPROM. Three digits will appear on the LCD; the first digit indicates the software revision number, and the remaining two digits indicate the error code number (CADD-PLUS and CADD-TPN pumps only). The order of the numbers is reversed for the CADD-1 series and CADD-PCA series pumps. (See Figure 17.) These three digits will remain in memory and will appear on the LCD upon each power-up until another fault occurs. (See "Testing Procedures" starting on page 30 of this manual for detailed instructions regarding the power-up check.) Thus, there is always a record of the last internal fault detected by the microprocessor.

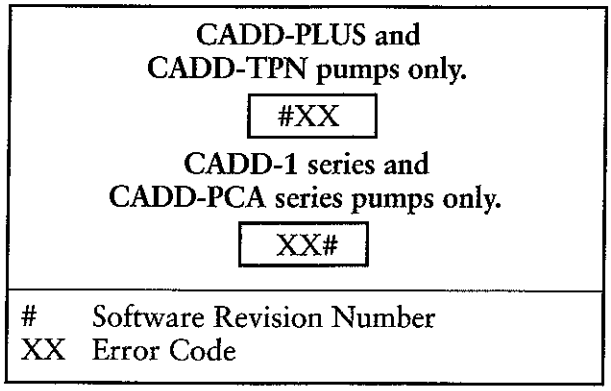


Figure 17. Error Code Displays

Error Codes

The error codes and their meanings follow:

FF3 – Pump is OK. Empty register. Error history is blank (5100, 5200, and 5200P only).

FF – General error.

NOTE:

If the display shows an FF3 code on the CADD-1 Models 5100 and CADD-PCA Models 5200, 5200P, ***this is not an error condition.*** Do not return the pump for servicing. The FF3 indicates that the error register of the computer's memory is blank. If any other FF error other than FF3 in these specific pumps should occur, the pump should be returned for service.

00 – Timer Control Register error (incorrect data loaded into the timer prescaler).

03 – Timer Control Register error (incorrect data loaded into the timer prescaler).

07 – Software Interrupt error (software error if program malfunctions).

10 – ID Activations Count error.

13 – Optical Switch low at incorrect time (motor may have activated without being commanded).

18 – Power-up I/O port check error (problem with microprocessor I/O ports).

19 – Basal or ID data above limit (rate data is set higher than the limit, internal data error).

21 – Power-up RAM check failed (data in the microprocessor internal RAM is corrupted).

25 – Error on read of calibration data (calibration data corrupted).

29 – Redundant data check failed (EEPROM data corrupted).

30 – Stack overwrites RAM error (last bit in RAM return address is overwritten by stack).

35 – Not "I" or "C" mode error (EEPROM power-up error)

40 – Error in BCD, ADD, or TIM programs (mathematical software problem)

43 – Critical RAM checksum error (data corrupted)

44 – Run-time RAM checksum error (data corrupted)

46 – Pump is OK. Checksum error with bank switch

NOTE:

If the CADD-TPN pump shows a code number 46, ***the pump does not need to be returned for servicing.*** When an error code number 46 occurs, the computer's memory is being re-initiated, and all programmed data has been lost and must be re-entered. The pump will be in Lock Level 2. "OFF" will appear on the RES VOL display, and all other programmed functions will have default values. (See Section 4.4 in the *CADD-TPN System Operator Manual* for default values.)

47 – Checksum error (EEPROM data corrupted).

48 – Time out error during EEPROM write (nonvolatile memory storage error).

51 – Keyboard key not recognized (illegal code received from the keyboard encoder, only eight of the sixteen possible codes are legal).

55 – Function error code (software error for function check problem).

60 – High bank vector error (general program malfunction).

63 – ROM check failed (program PROM data error).

72 – Concentration check error (data corrupted).

73 – RAM redundant check error (corrupted data in microprocessor RAM).

74 – RAM region flag error (data corrupted).

75 – Pump interval RAM error (calculation data error).

88 – Flag to turn on motor is wrong (flag for pump routine is incorrect)

91 – Error from active program (software activation calculations error).

93 – Set key error (microprocessor internal data error).

99 – Motor fault (camshaft did not complete one revolution in less than two seconds).

11 Cleaning and Inspection Procedures

Inspection Recommendation

Deltec recommends annual functional inspection on CADD pumps. The following inspection and testing procedures should be performed annually to verify function and accuracy.

NOTE:

Persons performing the following tests and procedures should be familiar with Deltec CADD pumps. Please read the *Operator's Manuals* supplied with the pumps before proceeding.

WARNING:

CADD pumps are sealed units. A broken or damaged seal will, therefore, be considered conclusive evidence that the pump has been misused and/or altered, which voids any and all warranties. All service and repair of CADD pumps must be performed by Deltec or its authorized agents.

Cleaning

CAUTION:

- **Do not immerse the pump in cleaning fluid or water. Do not allow solution to soak into the pump, accumulate on the keypad, or enter the battery compartment.**
- **Do not clean the pump with acetone, other plastic solvents, or abrasive cleaners.**

Use any of the following solutions to clean the pump and accessories:

- Soap solution
- Benzalkonium chloride concentrate (0.13%)
- Glutaral concentrate, USP (2%)
- 10 percent solution of household bleach (one part household bleach to nine parts water)
- Alcohol, USP (93%)
- Isopropyl Alcohol, USP (99%)
- PDI - Super Sani-cloth®
- Mada Medical - MadaCide

1. Dampen a soft, lint-free cloth with cleaning solution. Apply the solution to exterior surface of the pump or accessory. Do not allow the solution to soak into the pump or accessory.
2. Wipe the entire surface dry with another soft, lint-free cloth. Allow the pump to dry completely before use.

Visual Inspection

- Visually inspect the pump for any damage to the LCD, occlusion pressure switch, valves and expulsor, reservoir hinge area, latch, keyboard, and housing. On the CADD-PCA 5800R pump, check the pins on the LEMO connector of the REMOTE DOSE cord for proper alignment.
- Check the battery door for proper operation. It should not be broken. The mating tabs on the pump housing should not be broken.
- Examine the battery compartment for damage. If the battery contacts appear corroded, clean them with a cotton swab and isopropyl alcohol. If the battery contacts appear to be bent or pushed in, straightening may be possible with a small screwdriver or other suitable tool. Care must be taken so as not to damage the pump housing or to incur further damage to the contacts. The battery contacts should angle back toward the battery near the bottom of the contact.

Mechanical Inspection

- Press each key on the keyboard. Each key should have a distinctive dome feeling. The keys should not feel flat.
- Attach the battery door. The battery door should fit snugly in place when it is closed on the pump.
- Attach either a 50- or 100-ml Medication Cassette reservoir or CADD-TPN administration set to the pump. Check for smooth operation and a definite "feel" when the latch pulls the Medication Cassette reservoir or CADD-TPN administration set firmly against the bottom of the pump. The slot or grooves of the locking button should be aligned with the seam or, in newer models, with the "LOCKED" indicator on the side of the pump housing.

12 Testing Procedures

Functional Testing

CADD-1 Pump
Models 5100, 5100 HF, 5101 HF, 5100 HFX

Power-up Check – Model 5100:

- Insert a battery in the pump and observe the LCD during power up. If three digits appear prior to the pump reviewing the current program settings, check to see if all previously programmed settings have been cleared to the lowest programmable values and that the pump is in LL2. If so, the pump should be returned for service. If not, continue with the LCD check.

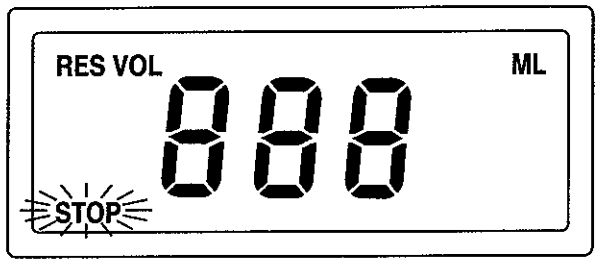
Power-up Check – Models 5100 HF, 5101 HF, 5100 HFX:

- Insert a battery in the pump and observe the LCD during power up. If three digits appear (rather than the single digit software revision number) prior to the pump reviewing the current program settings, this is the software revision plus an error code. The pump has experienced an electrical or mechanical fault and should be returned for service. (An explanation of the error codes can be found on page 27 of this manual.) If one digit appears, this is the software revision. The pump has powered up normally. The pump should sequentially display all of the programmed values and beep six times. Each annunciator should operate properly for each setting. The LO BAT annunciator should also disappear from the display. Continue with the LCD check.

The following three checks (LCD, motor and gear train, and RES VOL alarm) should be performed in the sequence shown here.

LCD Check:

- Place the pump in Lock Level 0 (LL0). With the pump in the RES VOL mode, scroll down to 888. Check that each segment of the LCD appears on the display.



- Scroll up to 001. Press the SET/CLEAR key and observe the display. The RES VOL and STOP annunciators should both be flashing.

Motor and Gear Train Check:

- Press and hold the PRIME key until three P's (PPP) appear on the display. Release the PRIME key. Now press and continue to hold the PRIME key. The pump should begin to prime. While priming the pump, listen to the motor for excessive noise or grinding sounds. Count the number of pump activations. The CADD-1 pump should prime ten activations and then stop. The display should show a RES VOL of 001.

RES VOL Alarm Check:

- Prime the pump again. After ten activations, the pump should stop and alarm by sounding two beeps every second. The pump should also return to the RES VOL mode and show 000 on the display. Now press the SET/CLEAR key. The alarm should be silenced, and the display should again show a RES VOL of 001.

Starting/Stopping the Pump:

- Check the STOP/START key by pressing and holding it. Three dashes (– – –) should disappear from the display one-by-one. The pump should then sequentially display all of the programmed values. The STOP annunciator should no longer be present. Now press and hold the STOP/START key. Three dashes (– – –) should again appear one-by-one. STOP should flash on the display.

Activation Timing Check:

- Check the activation timing by programming the pump with the following values:

  RES VOL: 001 ml

  RATE: 288 ml/24hrs

  GIVEN: 000 ml (Press SET/CLEAR)

- Press and hold the STOP/START key. Simultaneously, start a timer. Three dashes (– – –) should disappear from the display one-by-one. The pump should sequentially display all of the programmed values.
- Count the activations. One activation should occur every fifteen seconds. Approximately five minutes seven seconds (5:07) and twenty activations after first pressing the STOP/START key, the RES VOL alarm will occur. The display should show a RES VOL of 000 and a GIVEN value of 001.

CADD-PCA Pump
Models 5200, 5200P, 5200 PXC

Power-up Check – Model 5200 and 5200P:

- Insert a battery in the pump and observe the LCD during power up. The display will become blank. If three digits appear prior to the pump reviewing the current program settings, check to see if all previously programmed settings have been cleared to the lowest programmable values, and that the pump is in LL2. If so, the pump should be returned for service. If not, continue with the LCD check.

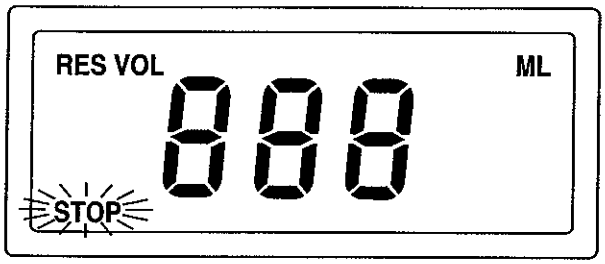
Power-up Check – Model 5200 PXC:

- Insert a battery in the pump and observe the LCD during power up. The display will become blank. If three digits appear (rather than the single digit software revision number) prior to the pump reviewing the current program settings, this is the software revision plus an error code. The pump has experienced an electrical or mechanical fault and should be returned for service. (An explanation of the error codes can be found on page 27 of this manual.) If one digit appears, this is the software revision. The pump has powered up normally. The pump should sequentially display all of the programmed values and beep six times. Each annunciator should operate properly for each setting. The LO BAT annunciator should also disappear from the display. Continue with the LCD check.

The following three checks (LCD, motor and gear train, and RES VOL alarm) should be performed in the sequence shown here.

LCD Check:

- Place the pump in Lock Level 0 (LL0). With the pump in the RES VOL mode, scroll down to 888. Check that each segment of the LCD appears on the display.



- Scroll up to 001. Press the SET/CLEAR key and observe the display. The RES VOL and STOP annunciators should both be flashing.

Motor and Gear Train Check:

- Press and hold the PRIME key until three P's (PPP) appear on the display. Release the PRIME key. Now press and continue to hold the PRIME key. The pump should begin to prime. While priming the pump, listen to the motor for excessive noise or grinding sounds. Count the number of pump activations. The CADD-PCA pump (Models 5200, 5200P, and 5200 PXC) should prime ten activations and then stop. The display should show a RES VOL of 001.

RES VOL Alarm Check:

- Prime the pump again. After ten activations, the pump should stop and alarm by sounding two beeps every second. The pump should also return to the RES VOL mode and show 000 on the display. Now press the SET/CLEAR key. The alarm should be silenced, and the display should again show a RES VOL of 001.

Starting/Stopping the Pump:

- Check the STOP/START key by pressing and holding it. Three dashes (– – –) should disappear from the display one-by-one. The pump should then sequentially display all of the programmed values. The STOP annunciator should no longer be present. Now press and hold the STOP/START key. Three dashes (– – –) should again appear one-by-one. STOP should flash on the display.

DOSE Key Check:

- Check the DOSE key operation by programming the pump with the following values:

RES VOL:	010 ml
MG/ML:	01.0 mg/ml
RATE:	00.0 mg/hr
ID MG:	01.0 mg
ID MINUTES:	005 min
ID/HR:	001/hr
ID GIVEN:	000 (Press SET/CLEAR)
MG GIVEN:	000 mg (Press SET/CLEAR)

- Press and hold the STOP/START key. Three dashes (– – –) should disappear from the display one-by-one. The pump should sequentially display all of the programmed values.
- Now press the DOSE key and note the time. The pump should beep twice and begin to deliver. Count the number of pump activations. The pump should make twenty activations. After twenty activations the display should show a RES VOL of 009. Press the DOSE key two more times within the next five minutes. (The pump should not deliver.)

ID GIVEN Mode Check:

- Stop the pump by pressing and holding the STOP/START key until three dashes (– – –) appear on the display. Use the SELECT MODE key to advance the LCD to the ID GIVEN screen. The display should show 001. Press the SET/CLEAR key. The display should now show 000.

MG GIVEN Mode Check:

- Press the SELECT MODE key to advance the display to the MG GIVEN screen. The display should now show 001. Press the SET/CLEAR key. The display should now show 000.

Activation Timing Check:

- Check the activation timing by programming the pump with the following values:

RES VOL:	001 ml
MG/ML:	01.0 mg/ml
RATE:	18.0 mg/hr
ID MG:	00.0 mg
ID GIVEN:	000 (Press SET/CLEAR)
MG GIVEN:	000 mg (Press SET/CLEAR)

- Press and hold the STOP/START key. Simultaneously, start a timer. Three dashes (– – –) should disappear from the display one-by-one. The pump should sequentially display all of the programmed values.
- Count the activations. One activation should occur every ten seconds. Approximately three minutes thirty-one seconds (3:31) and twenty activations after first pressing the STOP/START key, the RES VOL alarm will occur. The display should show a RES VOL of 000 and an MG GIVEN value of 001.

CADD-PCA Pump
Models 5800 and 5800R

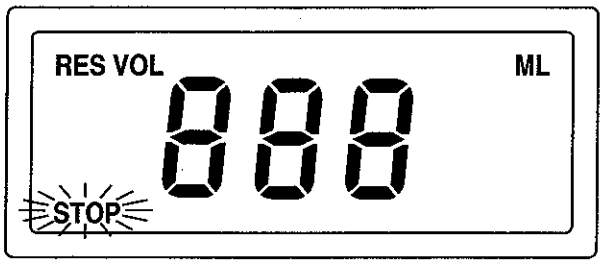
Power-up Check:

- Insert a battery in the pump and observe the LCD during power up. The display will become blank. If three digits appear, this is the software revision plus an error code. The pump has experienced an electrical or mechanical fault and should be returned for service. (An explanation of the error codes can be found on page 27 of this manual.) If one digit appears, this is the software revision. The pump has powered up normally. The pump should sequentially display all of the programmed values and beep six times. Each annunciator should operate properly for each setting. The LO BAT annunciator should also disappear from the display. Continue with the LCD check.

The following three checks (LCD, motor and gear train, and RES VOL alarm) should be performed in the sequence shown here.

LCD Check:

- Place the pump in Lock Level 0 (LL0). With the pump in the RES VOL mode, scroll down to 888. Check that each segment of the LCD appears on the display.



- Scroll up to 002. Press the SET/CLEAR key and observe the display. The RES VOL and STOP annunciators should both be flashing.

Motor and Gear Train Check:

- Press and hold the PRIME key until three P's (PPP) appear on the display. Release the PRIME key. Now press and continue to hold the PRIME key. The pump should begin to prime. While priming the pump, listen to the motor for excessive noise or grinding sounds. Count the number of pump activations. The CADD-PCA pump (Models 5800 and 5800R) should prime twenty activations and then stop. The display should show a RES VOL of 001.

RES VOL Alarm Check:

- Prime the pump again. After twenty activations, the pump should stop and alarm by sounding two beeps every second. The pump should also return to the RES VOL mode and show 000 on the display. Now press the SET/CLEAR key. The alarm should be silenced, and the display should again show a RES VOL of 002.

Starting/Stopping the Pump:

- Check the STOP/START key by pressing and holding it. Three dashes (– – –) should disappear from the display one-by-one. The pump should then sequentially display all of the programmed values. The STOP annunciator should no longer be present. Now press and hold the STOP/START key. Three dashes (– – –) should again appear one-by-one. STOP should flash on the display.

DOSE Key Check:

- Check the DOSE key operation by programming the pump with the following values:

RES VOL:	010 ml
MG/ML:	01.0 mg/ml
RATE:	00.0 mg/hr
DOSE:	01.0 mg
DOSE MIN:	005 min
DOSE/HR:	012/hr
DOSE GIVEN:	000 (Press SET/CLEAR)
MG GIVEN:	000 mg (Press SET/CLEAR)

- Press and hold the STOP/START key. Three dashes (– – –) should disappear from the display one-by-one. The pump should sequentially display all of the programmed values.
- Now press the DOSE key and note the time. The pump should beep twice and begin to deliver. Count the number of pump activations. The pump should make twenty activations. After twenty activations the display should show a RES VOL of 009. Press the DOSE key two more times within the next 5 minutes. (The pump should not deliver.)

REMOTE DOSE Cord Check (Model 5800R Only):

Wait 5 minutes after the dose given above; then, instead of pressing the DOSE key, press the button on the REMOTE DOSE cord. The pump should make twenty activations. After twenty activations, the display should show a RES VOL of 008. Press the DOSE key two more times within the next 5 minutes. (The pump should not deliver.)

DOSE GIVEN and Doses Attempted Mode Check:

- Stop the pump by pressing and holding the STOP/START key until three dashes (– – –) appear on the display. Use the SELECT MODE key to advance the LCD to the DOSE GIVEN screen. On the 5800 Model, the display should show 001, and on the 5800R Model, the display should show 002.
- Press the up or down SCROLL key. The display should now show DOSE and 003 on the 5800 Model, or 006 on the 5800R Model. Press the SET/CLEAR key. The display should now show 000.

MG GIVEN Mode Check:

- Press the SELECT MODE key to advance the display to the MG GIVEN screen. The display should now show 002 on the 5800R model, or 001 on the 5800 model.
- Press the SET/CLEAR key. The display should now show 000.

Activation Timing Check:

- Check the activation timing by programming the pump with the following values:

RES VOL:	001 ml
MG/ML:	01.0 mg/ml
RATE:	18.0 mg/hr
DOSE:	00.0 mg
MG GIVEN:	000 mg (Press SET/CLEAR)

- Press and hold the STOP/START key. Simultaneously, start a timer. Three dashes (– – –) should disappear from the display one-by-one. The pump should sequentially display all of the programmed values.
- Count the activations. One activation should occur every ten seconds. Approximately three minutes thirty-one seconds (3:31) and twenty activations after first pressing the STOP/START key, the RES VOL alarm will occur. The display should show a RES VOL of 000 and an MG GIVEN value of 001.

CADD-PLUS Pump Model 5400

Power-up Check:

- Insert a battery in the pump and observe the LCD during power up. The display will become blank. If three digits appear, this is the software revision plus an error code. The pump has experienced an electrical or mechanical fault and should be returned for service. (An explanation of the error codes can be found on page 27 of this manual.) If one digit appears, this is the software revision. The pump has powered up normally. The display should then show either a "C" for the Continuous mode, or an "I" for the Intermittent mode.

NOTE:

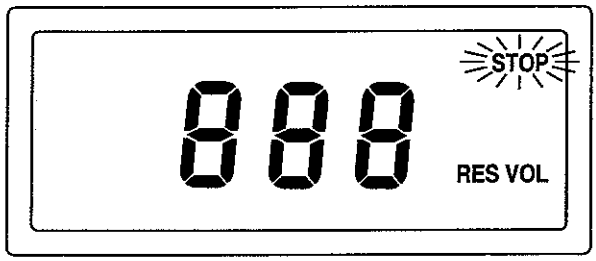
If "I" or "C" does not appear on the display, the pump should be placed in Lock Level 0 and the battery should be reinserted.

- Press the SELECT MODE button until "I" (Intermittent mode) appears on the display. Now press the SET/CLEAR key. The pump should sequentially display each of the programmed values in the Intermittent mode. Each annunciator should operate properly for each of the screens.
- Remove and reinsert the battery. Press SELECT MODE until "C" (Continuous mode) appears on the display. Now press the SET/CLEAR key. The pump should sequentially display each of the programmed values in the Continuous mode. Each annunciator should operate properly for each of the screens.

The following three checks (LCD, motor and gear train, and RES VOL alarm) should be performed in the sequence shown here.

LCD Check:

- Place the pump in Lock Level 0 (LL0). With the pump in the RES VOL mode, scroll down to 888. Check that each segment of the LCD appears on the display.



- Scroll up to 001. Press the SET/CLEAR key and observe the display. The STOP annunciator should be flashing.

Motor and Gear Train Check:

- Press and hold the PRIME key until three P's (PPP) appear on the display. Release the PRIME key. Now press and continue to hold the PRIME key. The pump should begin to prime. While priming the pump, listen to the motor for excessive noise or grinding sounds. Count the number of pump activations. The CADD-PLUS pump should prime ten activations and then stop. The display should show a RES VOL of 001.

RES VOL Alarm Check:

- Prime the pump again. After ten activations, the pump should stop and alarm by sounding two beeps every second. The pump should also return to the RES VOL mode and show 000 on the display. Now press the SET/CLEAR key. The alarm should be silenced, and the display should again show a RES VOL of 001.

Starting/Stopping the Pump:

- Check the STOP/START key by pressing and holding it. Three dashes (– – –) should disappear from the display one-by-one. The pump should then sequentially display all of the programmed values. The STOP annunciator should no longer be present. Now press and hold the STOP/START key again. Three dashes (– – –) should appear one-by-one. STOP should flash on the display.

Activation Timing Check:

- Check the activation timing by programming the pump in the Continuous ("C") mode with the following values:

  RES VOL: 001 ml

  RATE: 60.0 ml/hr

  GIVEN: 000 (Press SET/CLEAR key)

- Press and hold the STOP/START key. Simultaneously, start a timer. Three dashes (– – –) should disappear from the display one-by-one. The pump should sequentially display all of the programmed values.
- Count the activations. One activation should occur every three seconds. Approximately one minute eight seconds (1:08) and twenty activations after first pressing the STOP/START key, the RES VOL alarm will occur. The display should show a RES VOL of 000 and a GIVEN value of 001.

CADD-TPN Pump
Model 5700

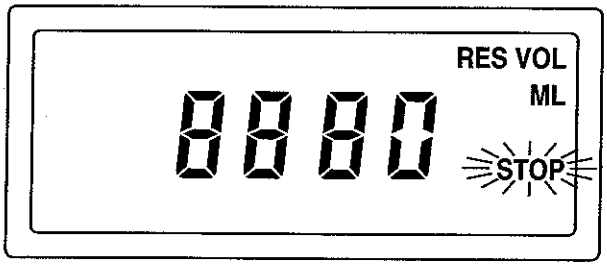
Power-up Check:

- Insert a battery in the pump and observe the LCD during power up. The display will become blank. If three digits appear, this is the software revision plus an error code (other than code number 46). The pump has experienced an electrical or mechanical fault and should be returned for service. (An explanation of the error codes can be found on page 27 of this manual.) If one digit appears, this is the software revision. The pump has powered up normally. The pump should sequentially display all of the programmed values and beep six times. Each annunciator should operate properly for each setting. The LO BAT annunciator should also disappear from the display. Continue with the LCD check.

The following three checks (LCD, motor and gear train, and RES VOL alarm) should be performed in the sequence shown here.

LCD Check:

- Place the pump in Lock level 0 (LL0). With the pump in the RES VOL mode, scroll down to 8880. Check that each segment of the LCD appears on the display.



- Scroll up to 0010. Press the SET/CLEAR key and observe the display. The STOP annunciators should be flashing.

Motor and Gear Train Check:

- Press and hold the PRIME key until three P's (PPP) appear on the display. Release the PRIME key. Now press and continue to hold the PRIME key. The pump should begin to prime. While priming the pump, listen to the motor for excessive noise or grinding sounds. Prime the pump for not more than twenty activations.

RES VOL Alarm Check:

- Prime the pump again until the pump stops and alarms by sounding two beeps every second. The pump should also return to the RES VOL mode and show 0000 on the display. Now press the SET/CLEAR key. The alarm should be silenced, and the display should again show a RES VOL of 0010.

Starting/Stopping the Pump:

- Check the STOP/START key by pressing and holding it. Three dashes (– – –) should disappear from the display one-by-one. The pump should then sequentially display all of the programmed values. The STOP annunciator should no longer be present. Now press and hold the STOP/START key. Three dashes (– – –) should again appear one-by-one. STOP should flash on the display.

Activation Timing Check:

- Check the activation timing by programming the pump with the following values:

RES VOL:	0010 ml
INFUSION ML:	0040 ml
INFUSION PERIOD:	00:10 hr:mn
TAPER ↑:	00:00 hr:mn
TAPER ↓:	00:00 hr:mn
RATE: (Nonprogrammable display)	240 ml/hour
ML GIVEN: (Press SET/CLEAR)	0000 ml

- Press and hold the STOP/START key. Simultaneously, start a timer. Three dashes (– – –) should disappear from the display one-by-one. The pump should sequentially display all of the programmed values.
- Count the activations. One activation should occur about every four seconds. Approximately two minutes fifty-two seconds (2:52) after first pressing the STOP/START key, the RES VOL alarm will occur. The display should show a RES VOL of 0000 and a GIVEN value of 0010.

Occlusion Pressure-Switch Test

CADD-1 Models, 5100 HF and 5101 HF; CADD-PCA, Models 5200 P and 5200 PXC:

1. Gently depress the domed switch on the bottom of the pump with a fingertip. **DO NOT USE A FINGERNAIL. A fingernail or other sharp object could damage the sensor.** The pump should alarm and HI P should appear on the display. Release the switch. The pump should continue to alarm until the battery is removed.
2. Remove and replace the battery. Observe the display after the power-up sequence. The alarm should be silenced, and HI P should not appear on the display.

CADD-1 Model 5100 HFX, CADD-PCA Models 5800 and 5800R, CADD-PLUS Model 5400, and CADD-TPN Model 5700:

1. Gently depress the domed switch on the bottom of the pump with a fingertip. **DO NOT USE A FINGERNAIL.** A fingernail or other sharp object could damage the sensor. The pump should alarm and HI P should appear on the display. Release the switch. The alarm should be silenced, and HI P should not appear on the display.

Occlusion Pressure Range Tests

NOTE:

Occlusion pressure range tests may be performed on CADD-1 Models 5100 HF, 5101 HF, and 5100 HFX pumps; CADD-PCA Models 5200P, 5200 PXC and 5800 pumps; the CADD-PLUS Model 5400 pump; and the CADD-TPN Model 5700 pump. (For the CADD-TPN pump occlusion test, see page 41 of this manual.)

Occlusion Pressure Range Test I
(CADD-1, CADD-PLUS and CADD-PCA Pumps)

Description:

Pressure is applied by attaching a small syringe to a pump with a filled Medication Cassette reservoir. The plunger is then depressed until the occlusion alarm is activated. Do not fill the syringe with water.

Equipment needed:

- 50- or 100-ml Medication Cassette reservoir containing distilled water.
- 1-ml syringe.

Procedure:

1. Insert a battery and wait for the pump to power up.
2. Attach a Medication Cassette reservoir containing water to the pump.
3. Prime the Medication Cassette reservoir tubing. The tubing should be filled with fluid to the end of the luer lock connector. The system MUST be free from air bubbles for this test.
4. Withdraw the plunger of the empty 1-ml syringe to the 1.0-ml marking. Now attach the syringe to the end of the Medication Cassette reservoir tubing.
5. Slowly depress the plunger of the syringe, noting when the HI P alarm is activated.
6. The pump should alarm when the syringe is between 0.5 ml and 0.1 ml.

Occlusion Pressure Range Test II
(CADD-1, CADD-PLUS and CADD-PCA Pumps)

Description:

An adjustable metered pressure source is connected to the Medication Cassette reservoir tubing. The pressure is slowly increased until the HI P alarm sounds.

Equipment needed:

- Pressure gauge, 45 psi ± 1 psi.
- Pressure source, 45 psi.
- Pressure regulator, 45 psi.
- Empty 50- or 100-ml Medication Cassette reservoir.

Procedure:

1. Insert a battery and wait for the pump to power up.
2. Attach a Medication Cassette reservoir to the pump.
3. Assemble the apparatus as shown in Figure 18.
4. Connect the Medication Cassette reservoir outlet tube to the metered pressure source.
5. Slowly increase the pressure, noting when the HI P alarm is activated.
6. The HI P alarm should sound between 16 and 40 psi (28 psi ± 12).

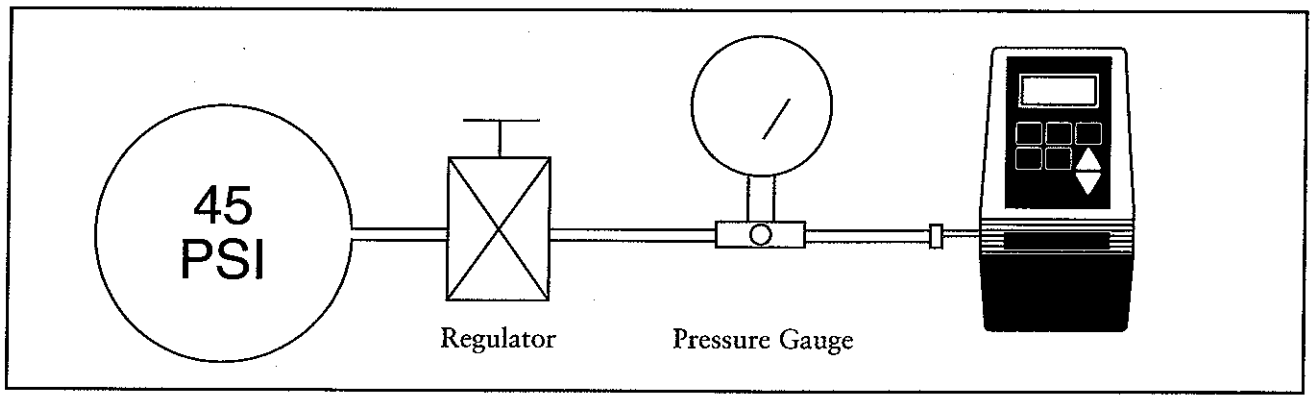


Figure 18. Occlusion test set-up.

Occlusion Pressure Range Test I
(CADD-TPN Model 5700 Pump only)

Description:

An administration set is attached to the CADD-TPN pump. The clamp next to the Y-site should be closed. When the pump is primed, pressure will be generated, causing the HI P alarm to sound.

Equipment needed:

- CADD-TPN administration set primed with distilled water.

Procedure:

1. Insert a battery and wait for the pump to power up.
2. Attach the primed administration set to the CADD-TPN pump.
3. Remove air from the filter. Tape over all air vents on the filter.

NOTE:

Place the filter housing in a vertical position with the outlet tube pointing up. This will reduce the number of air bubbles that may become trapped in the filter support ribs. The parallel lines will be facing you. Release the clamp. Initiate flow and observe that all air is expelled from the filter. If residual air remains, tap the filter housing while fluid flow continues, and the air will be expelled.

4. Clamp the administration set adjacent to the Y-site.
5. Prime the CADD-TPN pump and count the number of activations that occur before the HI P alarm sounds.
6. The pump should alarm through 2–7 activations.

Occlusion Pressure Range Test II
(CADD-TPN Model 5700 Pump only)

Description:

An adjustable metered pressure source is connected to the administration set tubing. The pressure is slowly increased until the HI P alarm sounds.

Equipment needed:

- Pressure gauge, 45 psi ± 1 psi.
- Pressure source, 45 psi.
- Pressure regulator, 45 psi.
- Administration set primed with distilled water.

Procedure:

1. Insert a battery and wait for the CADD-TPN pump to power up.
2. Attach a primed administration set to the pump.
3. Remove air from the filter. Tape over all air vents on the filter.
4. Assemble the apparatus as shown in Figure 18.
5. Connect the administration set outlet tube to the metered pressure source.
6. Slowly increase the pressure, noting when the HI P alarm is activated.
7. The HI P alarm should sound between 10 and 34 psi (22 psi ± 12).

Gravimetric Accuracy Testing
(CADD-1, CADD-PLUS and CADD-PCA Pumps)

Description:

A Medication Cassette reservoir is partially filled with water and weighed. The reservoir is then attached to the pump and the pump is set to deliver a certain amount of water. The reservoir is then removed and weighed again. The amount of water delivered is compared to the amount that the pump should have delivered.

Nominal system accuracy is given in the technical specifications sections for each pump. That is, under the test conditions described below, the accuracy of the pump and reservoir will be nominal with a 90% confidence level. The nominal test conditions are as follows: degassed water at 25 ± 5°C without back pressure.

Equipment needed:

- 50- or 100-ml Medication Cassette reservoir.
- 50- or 60-ml syringe.
- CADD extension set with anti-siphon valve
- A balance accurate to 0.1 g.
- 40 ml of room temperature water.

Procedure:

1. Fill the 50- or 60-ml syringe with 40 ml of water. Transfer the water into a Medication Cassette reservoir.
2. Remove any air from the Medication Cassette reservoir by aspirating the air with the syringe. Attach the CADD extension set with anti-siphon valve. Prime the tubing so it is filled with fluid to the end of the extension set luer lock connector.
3. Secure the slide clamp as close to the distal end of the extension set luer lock connector as possible.
4. Weigh the entire reservoir/extension set assembly and record the weight. This is the **predelivery weight.** (This weight includes the empty Medication Cassette reservoir, extension set and weight of the water.)
5. Attach the Medication Cassette reservoir to the pump. Program the RES VOL for 20 ml. Now press the SET/CLEAR key. This value is the **intended delivery volume.** (1 ml of water at 20°C weighs 1 gram.)
6. Program the pump for its maximum rate, using the parameters shown in Table 10. (The pump should be in Lock Level 0.)
7. Remove the slide clamp. Start the pump and allow it to deliver the RES VOL amount of 20 ml. At the end of delivery, the pump should alarm and the display will show RES VOL at 000.
8. Again, secure the slide clamp as close as possible to the distal end of the extension set luer lock connector. Remove the Medication Cassette reservoir from the pump and weigh the entire reservoir/extension set assembly. This is the **postdelivery weight.**
9. Calculate the difference in weight between the predelivery weight and the postdelivery weight. This is the **weight of the amount delivered.**
10. Find the difference between the volume of the amount delivered and the intended delivery volume. This is the **inaccuracy volume.**
11. Divide the inaccuracy volume by the intended delivery volume and multiply by 100. This is the **accuracy error percentage.** (See Table 11.)

Table 10. Parameters to set the maximum rate for each pump.

CADD-1	CADD-PCA 5200 Series	CADD-PCA 5800 Series	CADD-PLUS
RATE (ML/24 HOURS): 299 ml/24 hr	RATE: 19.9 mg/hr Concentration (MG/ML): 1.0 mg/ml	RATE: 20.0 ml/hr Concentration (MG/ML): 00.0 mg/ml	RATE (ML/HR): 75 ml/hr

12. If the accuracy error percentage is greater than ± 6%, repeat the test with a new reservoir. If the pump fails a second time, call Clinical Services.

EXAMPLE:

Predelivery Weight:	61.1 g
Postdelivery Weight:	- 41.6 g
Weight of Amount Delivered:	**19.5 g = 19.5 ml**
Volume of Amount Delivered:	19.5 ml
Intended Delivery Volume:	- 20.0 ml
Inaccuracy Volume:	**– 0.5 ml**
Inaccuracy Volume:	– 0.5 ml
Intended Delivery Volume:	÷ 20.0 ml
Accuracy Error:	**-0.025 ml**
Accuracy Error:	-0.025 x 100.00
Accuracy Error Percentage:	**–2.5%**

Gravimetric Accuracy Testing

(CADD-TPN Model 5700 Pump only)

Description:

A 100-ml flexible plastic bag reservoir (minibag), is partially filled with water and spiked to the administration set. The reservoir and set are then weighed. The administration set is attached to the pump and the pump is set to deliver a certain amount of water. The reservoir and set are then removed and weighed again. The amount of water delivered is compared to the amount that the pump should have delivered.

Nominal system accuracy is given in the Specification sections. That is, under the test conditions described below, the accuracy of the pump and administration set will be nominal with a 90% confidence level. The nominal test conditions are: degassed water at 25 ± 5°C without back pressure, with a CADD-TPN pump administration set.

Equipment Needed:

- CADD-TPN pump administration set.
- Empty 100-ml flexible plastic bag reservoir (minibag) or larger.
- CADD-TPN pump.
- 50- or 60-ml syringe.
- Balance accurate to 0.1 g.
- 80 ml of room temperature water.

Procedure:

1. Fill the empty 100-ml minibag with 80 ml of room temperature water, using the syringe.
2. Remove any air from the reservoir. Spike the CADD-TPN administration set into the reservoir. Gravity prime the system. Assure that all air is removed from the filter.
3. Place tape over all air vents to prevent inaccuracy caused by air entering the system.
4. Secure the clamp as close to the Y-site as possible, to assure minimum water loss from the CADD-TPN administration set.
5. Weigh entire reservoir and CADD-TPN administration set (grams) and record weight. This is the **predelivery weight.** (This weight includes the empty reservoir set weight along with the weight of the fluid.)

Table 11. Gravimetric percentage calculation for CADD-1, CADD-PCA and CADD-PLUS pumps.

Pre-Delivery Weight	Post-Delivery Weights	Weight of Amount Delivered	Intended Delivery Volume	Inaccuracy Volume	Accuracy Error	Accuracy Error Percentage
61.1 g	41.6 g	19.5 g = 19.5 m	20 ml	-0.5 ml	-0.5 ml ÷ 20.0 ml = -0.025	-0.025 x 100 = -2.5%

NOTE:

Perform this test with a balance that has at least a resolution of 0.1 grams.

6. Attach the administration set to the pump and set RES VOL for 50 ml. This is the **intended delivery volume.** (1 ml of water at 20°C weighs 1 gram.) Press the SET/CLEAR key within 15 seconds to set the value for RES VOL.
7. Program the pump with an infusion volume of 250 ml and an infusion period of 1 hour; the TAPER ↑ or TAPER ↓ values should be programmed to 00:00, and the result will be a delivery rate of 250 ml/hr.
8. Remove the slide clamp. Start the pump and allow it to make its full RES VOL delivery (50 ml). At the end of delivery, the pump should alarm and the display will show RES VOL at 0000.
9. Again, secure slide clamp as close as possible to Y-site. Remove the CADD-TPN administration set from the pump and weigh the entire reservoir and CADD-TPN administration set. This is the **postdelivery weight.**
10. Calculate the difference in weight between the predelivery weight and the postdelivery weight. This is the **weight of the amount delivered.** The weight of the amount delivered is equal to the volume of the amount delivered at 20°C.
11. Find the difference between volume of the amount delivered and the intended delivery volume. This is the **inaccuracy volume.**
12. Divide the inaccuracy volume by the intended delivery volume and multiply by 100. This is the **accuracy error percentage.** (See Table 12.)
13. If the accuracy error percentage is greater than ± 8%, repeat the test with a new CADD-TPN administration set. If the pump fails a second time, call Clinical Services.

EXAMPLE:

Predelivery Weight:	125.1 g
Postdelivery Weight:	- 76.5 g
Weight of Amount Delivered:	**48.6 g = 48.6 ml**
Volume of Amount Delivered:	48.6 ml
Intended Delivery Volume:	- 50.0 ml
Inaccuracy Volume:	**– 1.4 ml**
Inaccuracy Volume:	– 1.4 ml
Intended Delivery Volume:	÷ 50.0 ml
Accuracy Error:	**-0.028 ml**
Accuracy Error:	-0.028 x 100.00
Accuracy Error Percentage:	**–2.8%**

Table 12. Gravimetric percentage calculation for the CADD-TPN pump.

Pre-Delivery Weight	Post-Delivery Weights	Weight of Amount Delivered	Intended Delivery Volume	Inaccuracy Volume	Accuracy Error	Accuracy Error Percentage
125.1 g	-76.5 g	48.6 g = 48.6 m	50.0 ml	-1.4 ml	-1.4 ml ÷ 50.0 ml = -0.028	-0.028 x 100 = -2.8%

Volumetric Accuracy Testing
(CADD-1, CADD-PLUS and CADD-PCA Pumps)

Description

A predetermined amount of water is delivered into a collection device such as a burette or graduated cylinder. The amount of water delivered is compared to the amount that the pump should have delivered.

Nominal system accuracy is given in the technical specifications sections for each pump. That is, under the test conditions described below, the accuracy of the pump and reservoir will be nominal with a 90% confidence level. The nominal test conditions are as follows: degassed water at 25 ± 5°C without back pressure.

Equipment Needed

- 50 or 100 ml Medication Cassette reservoir*
- CADD extension set with anti-siphon valve*
- A fluid collection device such as a burette or a class A, 25 ml capacity graduated cylinder
- 40 ml of room temperature water

Procedure

1. Fill the Medication Cassette reservoir with at least 40 ml of room temperature water.
2. Remove any air from the Medication Cassette reservoir by aspirating the air with a syringe. Attach the CADD extension set with anti-siphon valve. Prime the tubing so it is filled with fluid to the distal end of the extension set luer lock connector.
3. Attach the end of the extension set to the fluid collection device.
4. Attach the Medication Cassette reservoir to the pump.
5. Program the pump using the parameters shown in Table 13.
6. The RES VOL of 20 ml is the **intended delivery volume.** Remove all clamps.
7. Start the pump.
8. CADD-1 and CADD-PLUS: Delivery will automatically begin and stop when the RES VOL reaches 000 ml.
9. CADD-PCA: Deliver a Clinician Activated Bolus of 20 ml. The pump will automatically stop when the delivery is complete.
10. When delivery is complete, record the volume of fluid delivered. This is the **actual delivery.**

Table 13. Programming parameters for CADD-1, CADD-PLUS and CADD-PCA pumps.

	CADD-1	CADD-PLUS (continuous mode)	CADD-PCA
RES VOL	20 ml	20 ml	20 ml
Concentration (MG/ML)	–	–	00.0 mg/ml
RATE	High Flow Mode	75 ml/hr	00.0 ml/hr
DOSE	–	–	00.0 ml
GIVEN	SET/CLEAR	SET/CLEAR	SET/CLEAR

Table 14. Volumetric percentage calculation for CADD-1, CADD-PLUS and CADD-PCA pumps.

Intended Delivery Volume	Actual Delivery Volume	Inaccuracy Volume	Accuracy Error	Accuracy Error Percentage
20 ml	19.5 ~~15.5~~ ml	-0.5 ml	-0.5/20 = -0.025	-0.025 x 100 +-2.5%

*A CADD administration set with anti-siphon valve may be substituted for a Medication Cassette reservoir and a CADD extension set with anti-siphon valve. Use a standard IV bag filled with at least 40 ml of room temperature and make sure all air is removed from the bag. Also, make sure there is no restriction of fluid flow from the bag to the pump.

11. Find the difference between the volume of the amount delivered and the intended delivery volume. This is the **inaccuracy volume.**
12. Divide the inaccuracy volume by the intended delivery volume and multiply by 100. This is the **accuracy error percentage.** (See Table 14.)
13. If the accuracy error percentage is greater than +/- 6%, repeat the test with a new reservoir. If the pump fails a second time, call Deltec's Customer Service department.

Volumetric Accuracy Testing
(CADD-TPN System)

Description

A predetermined amount of water is delivered into a collection device such as a burette or graduated cylinder. The amount of water delivered is compared to the amount that the pump should have delivered.

Nominal system accuracy is given in the technical specifications sections for each pump. That is, under the test conditions described below, the accuracy of the pump and reservoir will be nominal with a 90% confidence level. The nominal test conditions are as follows: degassed water at 25 ± 5°C without back pressure.

Equipment Needed

- CADD-TPN administration set with 0.2 or 1.2 micron filter.
- Standard IV bag filled with a minimum 50 ml of room temperature water.
- A fluid collection device such as a burette or a class A, 25 ml capacity graduated cylinder.

Procedure

1. Spike the IV bag and remove any air from the reservoir. Prime the tubing so it is filled with fluid to the end of the extension set luer lock connector.
2. Attach the end of the extension set to the fluid collection device.
3. Program the pump with the following program:

RES VOL	20 ml (This is the **intended delivery volume**)
INFUSION ML	20 ml
INFUSIONPERIOD	00:10
TAPER ↑	00:00
TAPER ↓	00:00
Rate (ML/HR)	120 ml/hr
ML GIVEN	SET/CLEAR

4. Attach the administration set to the pump.
5. Start the pump and deliver the full 20 ml.
6. When delivery is complete, record the volume of fluid delivered. This is the **actual delivery.**
7. Find the difference between the volume of the amount delivered and the intended delivery volume. This is the **inaccuracy volume.**
8. Divide the inaccuracy volume by the intended delivery volume and multiply by 100. This is the **accuracy error percentage.** (See Table 15.)
9. If the accuracy error percentage is greater than +/- 8%, repeat the test. If the pump fails a second time, call Deltec's Customer Service department.

Table 15. Volumetric percentage calculation for the CADD-TPN pump.

Intended Delivery Volume	Actual Delivery Volume	Inaccuracy Volume	Accuracy Error	Accuracy Error Percentage
20 ml	19.5 ml	-0.5 ml	-0.5/20 = -0.025	-0.025 x 100 +-2.5%

The following checklists are provided as guides only to assist in establishing documentation of cleaning and functional testing for CADD pumps. If service is required, fill out this sheet and return it with the device.

CADD Pump Cleaning and Functional Testing Checklist

CADD- _____ Model # _____ Serial # _____

Reference # _____ Date of Inspection _____ Testing Done By _____

(Refer to the Technical Manual for Deltec CADD pumps for procedures.)

I. Cleaning Completed ☐ Yes ☐ No

II. Visual Inspection

- ☐ LCD
- ☐ Valves and Expulsor
- ☐ Battery Contacts
- ☐ Keyboard
- ☐ Latch
- ☐ Occlusion Pressure Switch
- ☐ Pump Housing
- ☐ Battery Door
- ☐ REMOTE DOSE cord (Model 5800R only)
- ☐ Medication Cassette reservoir hinge area

III. Mechanical Inspection

- ☐ Keyboard
- ☐ Battery Door
- ☐ REMOTE DOSE cord (Model 5800R only)
- ☐ Medication Cassette reservoir latches properly onto pump

IV. Functional Inspection

CADD-1 Pump (Model 5100 Series)
- ☐ Power-up Check
- ☐ LCD Check
- ☐ Motor / Gear Train
- ☐ RES VOL Alarm
- ☐ Stop / Start Pump
- ☐ Activation Timing

CADD-PCA Pump (Model 5200 Series)
- ☐ Power-up Check
- ☐ LCD Check
- ☐ Motor / Gear Train
- ☐ RES VOL Alarm
- ☐ Stop / Start Pump
- ☐ DOSE Key Check
- ☐ ID GIVEN Check
- ☐ MG GIVEN Check
- ☐ Activation Timing

CADD-PCA Pump (Model 5800 Series)
- ☐ Power-up Check
- ☐ LCD Check
- ☐ Motor / Gear Train
- ☐ RES VOL Alarm
- ☐ Stop / Start Pump
- ☐ DOSE Key Check
- ☐ DOSE GIVEN Check
- ☐ Doses Attempted Check
- ☐ MG GIVEN Check
- ☐ Activation Timing
- ☐ REMOTE DOSE cord (Model 5800R only)

CADD-PLUS Pump (Model 5400)
- ☐ Power-up Check
- ☐ Intermittent
- ☐ Continuous
- ☐ LCD Check
- ☐ Motor / Gear Train
- ☐ RES VOL Alarm
- ☐ Stop / Start Pump
- ☐ Activation Timing

CADD-TPN Pump (Model 5700)
- ☐ Power-up Check
- ☐ LCD Check
- ☐ Motor / Gear Train
- ☐ RES VOL Alarm
- ☐ Stop / Start Pump
- ☐ Activation Timing

Description of Failure: _____

_____

_____

V. Occlusion Pressure Range (Perform either Test I or Test II.)
For Test I, volume remaining in syringe: _____ ml.
For Test II, HI P sounded at _____ psi.

VI. Gravimetric Accuracy Testing

Pre-Delivery Weight	Post-Delivery Weight	Weight of Amount Delivered	Intended Delivery Volume	Inaccuracy Volume	Accuracy Error	Accuracy Error Percentage
g	g	g = ml	ml	ml	ml ÷ ml =	× = %

Description of failure of any of the above tests: _____

_____

CADD Pump Maintenance Log

Pump Model	Pump Serial #	Customer Reference #	Inspection Date	Checked By